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OF
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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THE JOURNAL

OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

VOL. 33 MAY 1911 NUMBER 5

THE SPRING MEETING

Plans for the Spring Meeting, to be held in Pittsburg, Pa., May 30–June 2, are rapidly being matured, and the following tentative program is announced. The professional sessions at which such important questions as the application of mechanical engineering to cement manufacture, and the phases of steel works' practice involved in turbo-compressors and forging presses, should prove of unusual value and interest, together with the technical excursions arranged to supplement the papers which will be presented on these and other topics. As already announced, the Hotel Schenley will be the Society headquarters during the Convention and the professional sessions will be held at the Carnegie Institute. An invitation from the Engineers' Society of Western Pennsylvania for a smoker and entertainment to be held in their rooms on Friday evening, June 2, has been accepted by the Society with much appreciation.

PROGRAM

Tuesday Morning and Afternoon, May 30

Registration and reunion of members in the parlors of the Hotel Schenley.

Inspection of the Foundry and Machine Exhibition Company's Exhibit at Exposition Building.

Tuesday Evening

Informal reception for the members and ladies of the Society in the parlors of the Hotel Schenley.

Wednesday, May 31, 10 a. m.

MECHANICAL ENGINEERING OF CEMENT MANUFACTURE

Edison Roll Crushers, W. H. Mason.
Some Problems of the Cement Industry. Walter S. Landis.

Wednesday Afternoon

Excursion by special train to the plant of the Universal Portland Cement Company, Universal, upon invitation of Mr. E. M. Hagar, President.

The train will stop at East Pittsburg, both going and returning, to permit those who desire to inspect the works of the Westinghouse Electric & Manufacturing. Co. and the Westinghouse Machine Co.

Inspection of the Foundry and Machine Exhibition Company's Exhibit at Exposition Building.

Wednesday Evening, 8.30

MACHINE SHOP SESSION

The Assembling of Small Interchangeable Parts, John Calder.
Process of Assembling Small and Intricate Parts, Halcolm Ellis.
The Design of Milling Cutters and Their Efficiency, A. L. De Leeuw.

GAS POWER SESSION

Papers to be announced.

Thursday, June 1, 10 A. M.

MISCELLANEOUS SESSION

Stresses in Tubes, Reid T. Stewart.
Purchase of Coal on the Heat Unit Basis, D. T. Randall.

Energy and Pressure Drop in Compound Steam Turbines, F. E. Cardullo.
Pressure Recording Indicator for Punching Machinery, G. C. Anthony.

Thursday Afternoon

Boat excursion up the Monongahela River for members and ladies, including inspection trip to the National Tube Company's works at McKeesport.

Thursday Evening

Reception and dance at the Hotel Schenley.

Friday, June 2, 10 A. M.

STEEL WORKS PRACTICE

Commercial Application of the Turbine Turbo-Compressor, R. H. Rice.
Also papers on Blowing Engines and Hydraulic Forging Presses.

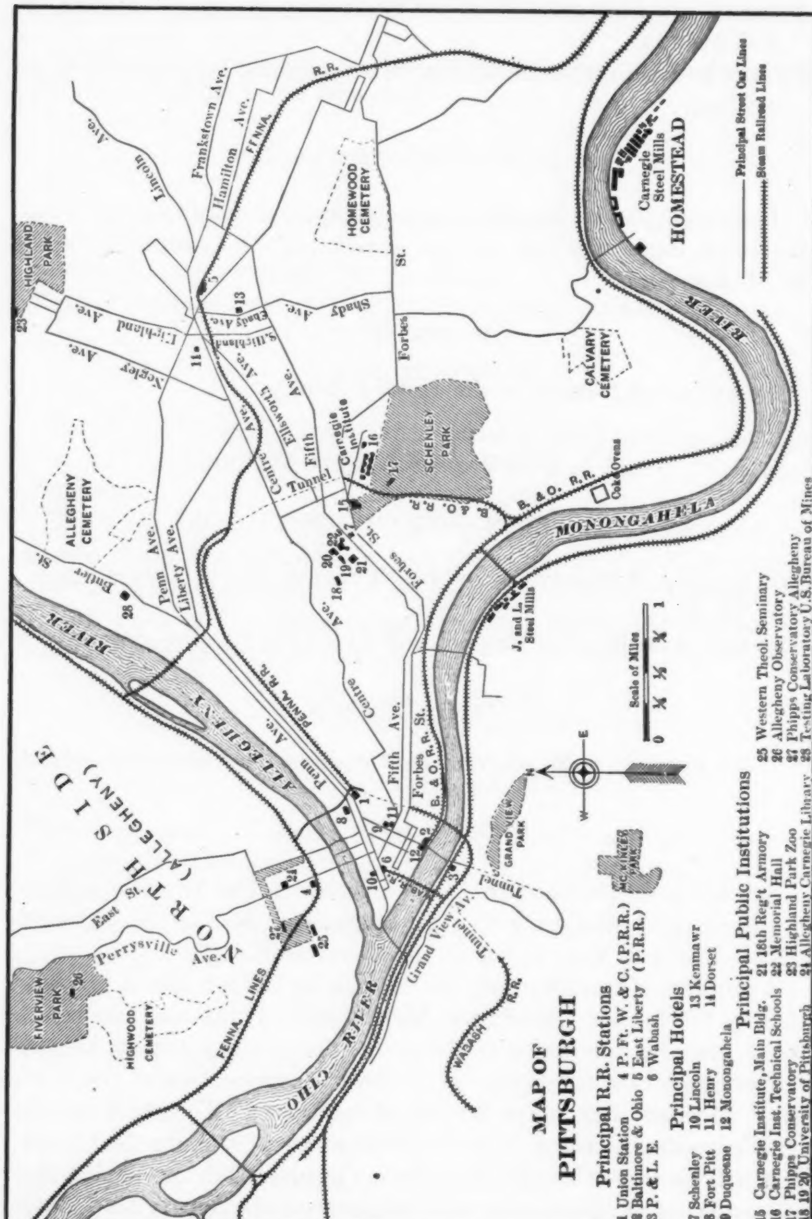
Friday Afternoon

Inspection trip to Mesta Machine Company's works at Homestead.

Friday Evening

Smoker and entertainment given in honor of The American Society of Mechanical Engineers by the Engineers' Society of Western Pennsylvania in their rooms in the Oliver Building.

A program of entertainment for the visiting ladies is also in preparation by the Ladies' Committee, Mrs. Chester B. Albree, Chairman, which includes in addition to the events above scheduled on the general program to which ladies are invited, the inspection of the Margaret Morrison School for Women of the Carnegie Technical Schools on Wednesday morning, with luncheon at the Pittsburg Golf Club. Tea will be served at the Twentieth Century Club on Wednesday afternoon, as an alternative entertainment to the trip to East Pittsburg. In the evening a visit will be made to the Carnegie Art Galleries, where the Annual Exhibit will be in progress. On Thursday


MAP OF PITTSBURGH
Principal R.R. Stations
1 Union Station
2 Baltimore & Ohio
3 P. & L. E.
4 P. Ft. W. & C. (P.R.R.)
5 East Liberty (P.R.R.)
6 Wabash
Principal Hotels
7 Schenley
8 Fort Pitt
9 Duquesne
10 Lincoln
11 Henry
12 Monongahela
13 Kenmawr
14 Dorset
Principal Public Institutions
15 Carnegie Institute, Main Bldg.
16 Carnegie Inst. Technical Schools
17 Phipps Conservatory
18 19 20 University of Pittsburgh
21 18th Reg't Armory
22 Memorial Hall
23 Highland Park Zoo
24 Allegheny Carnegie Library
25 Western Theol. Seminary
26 Allegheny Observatory
27 Phipps Conservatory Allegheny
28 Testing Laboratory U.S. Bureau of Mines
Scale of Miles
0 ¼ ½ ¾ 1
Principal Street Car Lines
Steam Railroad Lines
NORTH SIDE (ALLEGHENY)
ALLEGHENY RIVER
OHIO RIVER
MONONGAHELA RIVER
HOMESTEAD
Carnegie Steel Mills
J. and L. Steel Mills
Coke Ovens
SCHENLEY PARK
HIGHLAND PARK
RIVERVIEW PARK
GRAND VIEW PARK
McKINLEY PARK
ALLEGHENY CEMETERY
HOMEWOOD CEMETERY
CALVARY CEMETERY
HIGHWOOD CEMETERY
Carnegie Institute
Tunnel
Penn Ave.
Liberty Ave.
Fifth Ave.
Forbes St.
Centre Ave.
Ellsworth Ave.
Negley Ave.
Highland Ave.
S. Highland Ave.
Shady Ave.
Frankstown Ave.
Hamilton Ave.
Lincoln Ave.
Butler St.
East St.
Perrysville Ave.
Grand View Av.
PENNA. R.R.
PENNA. LINES
B. & O. R.R.
WABASH R.R.
R.R.

morning Carnegie Institute and the new Athletic Club will be open to inspection and on Friday morning the Heinz Pickle Works. On Friday there will also be automobile drives through the beautiful East End Parks and to Sewickley, with tea served at the Allegheny Country Club.

RAILROAD TRANSPORTATION NOTICE

Arrangements for hotel, transportation and Pullman car accommodations should be made personally.

Special concessions have been secured for members and guests attending the Spring Meeting in Pittsburg, May 30 to June 2, 1910.

The special rate of a fare and three-fifths for the round trip, on the certificate plan, is granted when the regular fare is 75 cents and upwards, from territory specified below.

a Buy your ticket at full fare for the going journey, between May 26 and June 1 inclusive. At the same time request a certificate, *not a receipt*. This ticket and certificate should be secured at least half an hour before the departure of the train.

b Certificates are not kept at all stations. Ask your station agent whether he has certificates and through tickets. If not, he will tell you the nearest station where they can be obtained. Buy a local ticket to that point, and there get your certificate and through ticket.

c On arrival at the meeting, present your certificate to S. Edgar Whitaker, office manager at the Headquarters. A fee of 25 cents will be collected for each certificate validated. No certificate can be validated after June 2.

d An agent of the Trunk Line Association will validate certificates, May 31, June 1, 2. No refund of fare will be made on account of failure to have certificate validated.

e One-hundred certificates and round trip tickets must be presented for validation before the plan is operative. This makes it important to show the return portion of your round trip ticket at Headquarters.

f If certificate is validated, a return ticket to destination can be purchased, up to June 6, on the same route over which the purchaser came, at three-fifths the rate.

The special rate is granted only for the following:
The Trunk Line Association:

All of New York east of a line running from Buffalo to Salamanca, all of Pennsylvania east of the Ohio River, all of New Jersey, Delaware and Maryland; also that portion of West Virginia and Virginia north of a line running through Huntington, Charleston, White Sulphur Springs, Charlottesville, and Washington, D. C.

The New England Passenger Association except via Eastern Steamship Co.

Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut.

LOCAL COMMITTEE

E. M. Herr, *Chairman*
Elmer K. Hiles, 2511 Oliver Bldg., *Secretary*
George Mesta, Chairman Committee on Finance
John M. Tate, Chairman Committee on Entertainment
Chester B. Albree, Chairman Committee on Hotels
Morris Knowles, Chairman Committee on Printing
D. F. Crawford, Chairman Committee on Transportation
Mrs. Chester B. Albree, Chairman Ladies' Committee

HOTEL RATES FOR SPRING MEETING AT PITTSBURG

Minimum Rates

	Without Bath			With Bath		
	Single Room	Single Room Two Persons	Double Room Two Persons	Single Room	Single Room Two Persons	Double Room Two Persons
Hotel Schenley	$2.00	$3.00	$—	$3.00	$4.00	$5.00
Fort Pitt Hotel	1.50	—	2.50	2.50	—	3.50
	2.00	—	3.00	5.00		7.00
Hotel Henry	1.50	2.50	3.00	2.50	3.50	4.00
	2.00	up	up	up	up	up
Monongahela House	1.50	—	2.00	2.50	—	4.00
	2.00		3.00	3.00		5.00
Hotel Anderson	1.00	1.50	3.00	2.50	—	4.00
		2.00	4.00	3.50		
Duquesne Hotel	1.50	—	2.50	2.50	—	3.50
Hotel Lincoln	1.50	—	2.00	2.00	—	3.00
	2.50	—	4.00	3.00		5.00
Seventh Avenue Hotel	1.50	2.50	3.00	2.50	4.00	5.00
Colonial Annex Hotel	1.50	2.00	2.50	2.00	3.00	3.50
						5.00
The Dorset	1.00	—	2.00	2.00	—	3.00
Hotel Lorraine*	2.50	—	4.00	3.00	—	5.00
				3.50		6.00

*American plan.

MONTHLY MEETINGS

NEW YORK MEETING, MAY 9

The subject to be considered at the New York meeting of the Society, to be held in the Engineering Societies Building on Tuesday evening, May 9, will be Patents. The purpose of the meeting is to outline to the engineer and manufacturer the fundamental principles of the patent law, the position and qualifications of a patent expert, and the industrial development for the purpose of establishing a patent monopoly. The whole question is rather one of pure and applied science than of law and for this reason interests engineers and those trained in the mechanic arts. It will be treated by such experts as E. W. Marshall, D. Howard Haywood, and Edwin J. Prindle, all of New York City, and will be discussed by a number of engineers and patent experts. The members of the Inventors' Guild have been especially invited to attend.

BOSTON MEETING, MAY 17

A meeting of the Society in Boston will be held on May 17 and will be conducted by the Boston Section of the American Institute of Electrical Engineers. A paper entitled, The Electric Motor in the World's Work, will be read by the author, Fred. M. Kimball, Associate A.I.E.E., manager of the small motor department of the General Electric Company, West Lynn, Mass.

PHILADELPHIA MEETING, JUNE 3

On account of the interest manifested on the subject of Fuel Testing, considered at the meeting in Philadelphia on April 22, when a paper by J. C. Parker of that city on the Work of the United States Fuel Testing Station was presented, the meeting on June 3 in that city will be given up to further discussion of the same topic. As this will follow immediately after the Spring Meeting in Pittsburg, members passing through Philadelphia will have an opportunity to be present and to take part in the discussion. The Engineers Club of Philadelphia will coöperate in the meeting.

ST. LOUIS MEETING, MARCH 25

A special meeting of the members of the Society in St. Louis was held on March 25, to meet President Meier, who gave an interest-

ing talk on the various questions concerning the meetings of the Society in different cities and the proposed rules governing these meetings which are now being established in the various localities. It was the sense of the meeting that the rules as proposed would be very satisfactory. It was moved and carried that an assessment be levied on the local membership to defray expenses incidental to meetings other than those called to consider technical subjects.

NEW YORK MEETING, APRIL 11

At a meeting of the Society in New York on April 11, agricultural machinery, with particular attention to the farm tractor, was the subject for consideration. L. W. Ellis, traction plowing specialist of the M. Rumely Company, La Porte, Ind., presented a paper on The Economic Importance of the Farm Tractor, which he regards as the solution of the present-day problems of the farm. This presentation was followed by a talk by Charles E. Lucke on the mechanical equipment of farm tractors, illustrated by views taken at the Canadian Industrial Exhibition held in Winnipeg, Manitoba, last summer, at which Dr. Lucke represented the International Harvester Company. Many questions concerning the various farm implements under discussion were answered by Dr. Lucke and Mr. Ellis. Written discussions of the paper by Mr. Ellis were submitted by G. W. Perry, sales manager of the Holt Caterpillar Company, Peoria, Ill.; by Putnam A. Bates, New York City; J. B. Davidson, professor of agricultural engineering, Iowa State College; George T. Powell, president of the Agricultural Experts Association, New York City; and O. B. Zimmerman, mechanical engineer of the M. Rumely Company, La Porte, Ind.

BOSTON MEETING, APRIL 21

At the meeting of the Society in Boston on April 21, the Boston Section of the American Institute of Electrical Engineers and the Boston Society of Civil Engineers coöperating, B. R. T. Collins, Mem. Am.Soc.M.E., with the Stone & Webster Engineering Corporation, Boston, presented his paper on Oil Fuel for Steam Boilers, dealing with the possible use of oil fuel for steam generating purposes in the Atlantic Coast states, its safety and permanency of supply, as well as conditions under which it may have special advantages over coal. The paper was discussed by E. H. Peabody, Mem Am.Soc.M.E., of the marine department, Babcock & Wilcox Co., New York; D. S.

Jacobus, Mem.Am.Soc.M.E., advisory engineer of the Babcock & Wilcox Co.; M. H. Bronsdon, chief engineer of the Rhode Island Co., Providence, R. I.; Edw. Robinson, Mem.Am.Soc.M.E., professor of mechanical engineering, University of Vermont; S. F. McIntosh, general engineer, American Optical Co., Southbridge, Mass.; Robt. C. Monteagle, Mem.Am.Soc.M.E., chief engineer of the Atlantic Works, East Boston; C. F. Dietz, Mem.Am.Soc.M.E., consulting engineer, Dietz & Keedy, Boston; F. J. Carty, with the Stone & Webster Engineering Corporation, Boston; F. C. Hovey, with Charles T. Main, Boston; J. C. Riley, Mem.Am.Soc.M.E., assistant professor of mechanical engineering, Massachusetts Institute of Technology; D. W. Robb, Mem.Am.Soc.M.E., president of the Robb Engineering Co., Ltd., Amherst, Canada; C. F. Baker, Mem.Am.Soc.M.E., Newton, Mass.; C. H. Parker, Mem.Am.Soc.M.E., assistant superintendent of the generating department, Boston Edison Co., Boston; and E. F. Miller, Mem.Am.Soc.M.E., professor of steam engineering, Massachusetts Institute of Technology. Professor Miller presided over the meeting, at which there was an attendance of 90.

PHILADELPHIA MEETING, APRIL 22

A meeting of the Society was held at the Engineers Club in Philadelphia on Saturday evening, April 22, with an attendance of 30. The paper of the evening, on the Work of the United States Fuel Testing Station, was presented by the author, J. C. Parker, general manager of the Parker Boiler Co., Phila. He showed numerous slides giving curves plotted from the results published by the United States Fuel Testing Station. A. S. Mann, fuel expert of the General Electric Company, Schenectady, N. Y., James Christie, consulting engineer, of Philadelphia, Francis Head, mechanical engineer, of the Bureau of Water, Philadelphia, and A. C. Wood, consulting engineer, of Philadelphia, discussed the paper.

BILL FOR LICENSING ENGINEERS

Col. E. D. Meier, President, and C. W. Rice, Secretary, attended a meeting of engineers on February 16, to consider the subject of laws for licensing engineers. Members of the American Society of Civil Engineers, the American Institute of Electrical Engineers, and the American Institute of Mining Engineers were present at the meeting and unanimously adopted the following resolution:

Whereas, the engineering profession is threatened with the passage of a Licensing Bill at Albany by the New York State Legislature, and

Whereas, the legislation proposed by the bills now in committee will operate to the serious disadvantage of our profession and the business interests of the State;

Now, therefore, be it resolved, That it is the unanimous opinion of the undersigned that it is to the interest of the engineering profession and the public that no license bill whatever be passed and that the presidents of the engineering societies be requested to appear in person, or by representative, at Albany at any of the hearings before the legislative committee which has the matter in charge, and vigorously oppose the passage of any bill for licensing engineers; and also that the various representatives of the societies, as above, shall get together to insure co-operative action.

Cary T. Hutchinson	S. L. F. Deyo
William Barclay Parsons	Rudolph Hering
Allen Hazen	Ralph D. Mershon
W. J. Wilgus	H. de B. Parsons
A. A. Stuart	Samuel Whinery
Ralph Chambers	A. W. K. Billings
Henry W. Hodge	George B. Francis
Calvin W. Rice	Frank J. Sprague
Charles Whiting Baker	E. D. Meier
Alfred P. Boller	R. S. Buck
L. B. Stillwell	

These resolutions were printed and distributed among the engineers of New York State.

On March 1, the Hoff Bill was considered by the Committee of the Assembly on General Laws. The bill was opposed in short speeches of five minutes each by Col. E. D. Meier, President Am. Soc. M. E., A. P. Boller, R. S. Buck, E. G. Spilsbury, Mem.Am.Soc.M.E., G. B. Francis, F. J. Sprague, and P. C. Ricketts, Mem.Am.Soc. M.E., who spoke against any and all bills; and by Judge Danneher,

retained by the Technical League of America, who opposed only the Hoff Bill and announced his intention of favoring the McGrath Bill. Mr. Tillson, representing the Brooklyn Society of Municipal Engineers, was the only one in favor of the Hoff Bill.

On March 14, a special committee again appeared before the Committee on Public Education to consider the McGrath Bill. Mr. Elliot, President of the Technical League of America, and Judge Danneher, counsel for the League, spoke in favor of the bill but offered to cut out each item to which the speakers raised objection. The principal speakers against the Bill were Mr. Merritt, minority leader in the House, James M. Dodge, Chairman of the Committee on Public Relations of the Society, Dean R. C. Ricketts, Mem. Am. Soc. M. E., representing Cornell, Rensselaer and Syracuse Universities, and Alfred P. Boller, Col. E. D. Meier, President Am.Soc.M.E., E. G. Spilsbury, Mem.Am.Soc.M.E., Frank J. Sprague. A resolution passed by the Engineering Society of Eastern New York, against any and all engineers' license bills, was presented by their secretary.

A special committee of engineers appointed by the General Committee, consisting of Col. E. D. Meier, President Am. Soc. M. E., Chairman, Alfred P. Boller, R. S. Buck, C. W. Baker, Mem.Am. Soc.M.E., George B. Francis, E. G. Spilsbury, Mem.Am.Soc. M.E., and Frank J. Sprague, is now collecting information in regard to the Hoff Bill, with a view to bring pressure to bear to defeat it. The principal danger in laws of this kind lies in the fact that if New York passes such a bill, many, if not all, of the other States will follow, and this will prove a tremendous burden on all engineers who have occasion to do professional work in different States, as reciprocity among them all will be difficult to obtain. It is proposed that when the question has been settled in New York State, the main arguments evolved in the discussion shall be printed and sent to the membership of the national societies, with the suggestion that they use these facts in opposing similar Bills hampering the profession in their States.

STUDENT BRANCHES

COLUMBIAN UNIVERSITY

At a meeting of the Columbia University Student Branch, April 3, Prof. C. W. Thomas, Mem.Am.Soc.M.E., delivered an illnstrated lecture on The Manufacture of Paper and the Details of Paper Machinery.

CORNELL UNIVERSITY

On March 1, the paper by F. H. Varney, Test of a 9000-Kw. Turbo-Generator Set, was read before the Sibley College Student Branch. Tests made by Prof. C. R. Carpenter, Mem.Am.Soc. M.E., at Richmond, Va., and at the Gold Street Station of the Brooklyn Edison Illuminating Company were also described. Col. E. D. Meier, President of the Society, addressed the meeting held March 17. He urged the students to get into touch with the national engineering societies and concluded with some interesting reminiscences of engineering during the Civil War.

OHIO STATE UNIVERSITY

Two papers taken from The Journal of the Society, one on Boiler Explosions by Mr. Allen and another on Safety Appliances by Mr. Pohlman, were read and discnssed before the Ohio State University Student branch at a meeting held March 21. Frederick W. Ives, Jun.Am.Soc.T.E., described the work of the University of Wisconsin Student Branch.

POLYTECHIC INSTITUTE OF BROOKLYN

Dr. D. S. Jacobus, Mem.Am.Soc.M.E., gave an illustrated lecture on Power Plant Economics before the Polytechnic Institute of Brooklyn Student Branch at their meeting, April 3. On April 8 an excursion to the Metropolitan Building to inspect the power plant was made.

PURDUE UNIVERSITY

At a meeting of the Purdue University Student Branch held March 25, A. E. Stuart, of the law firm Stuart, Hammond and Simms, representatives of the Wabash Railroad, talked on the The Law as It Applies to the Engineer. He touched on the law on rights, law relating to fixtures, mechanic's lien and the engineer as an expert witness. On April 11, M. J. Golden, Mem.Am.Soc.M.E., gave a lecture illustrated by lantern slides, upon several types of coke ovens.

STEVENS INSTITUTE OF TECHNOLOGY

At the meeting of the Stevens Institute of Technology Student Branch on March 16, Arthur F. Requa presented a paper upon the subject of Block Signalling. On March 24, at the annual dinner of the society, the following addresses were made: Engineering Efficiency, C. R. Schroeder; Engineering and the Public, Mr. Bauhan; Production or Industrial Engineering, H. H. Haynes; The Stevens Engineering Society, W. G. H. Brehmer; The Parting of the Ways, E. O. Hickstein.

UNIVERSITY OF CINCINNATI

The University of Cincinnati Student Branch held a meeting, April 7, at which E. F. Otting read a paper on System in a Modern Machine Shop. A paper by J. T. Rowell on The Humphrey Pump was also presented and both were followed by a general discussion by the members present.

UNIVERSITY OF ILLINOIS

At a meeting of the University of Illinois Student Branch held April 11, D. S. Knauss discussed The Application of the Slide Rule in the Machine Shop and J. N. Todd related his experiences in a foundry and machine shop.

UNIVERSITY OF MAINE

On February 18, the University of Maine Student Branch, together with the Maine branch of the American Institute of Electrical Engineers, visited the plant of the Bar Harbor and Union River Power Company at Ellsworth. At a meeting on March 18, C. C. Douglass, Mem.Am.Soc.M.E., addressed the members on the subject of Steam Turbines.

UNIVERSITY OF MISSOURI

The paper by John Calder on The Mechanical Engineer and Prevention of Accidents was presented and discussed by A. C. Edwards at a meeting of the University of Missouri Student Branch, on April 3.

UNIVERSITY OF WISCONSIN

The University of Wisconsin Student Branch held a meeting March 16 at which George A. Orrok, Mem.Am.Soc.M.E., talked on Blast Furnace Gas and Its Use in Internal-Combustion Engines.

YALE UNIVERSITY

At a meeting of the Yale Mechanical Engineers Club held April 4, Calvin W. Rice, Secretary of the Society, gave an illustrated lecture on the trip taken by the Society to England during the summer of 1910. The election of officers from the Junior class for next year resulted as follows: F. M. Jones, President; W. St. C. Childs, Secretary and Treasurer; T. Hyde, E. R. Shenk and D. T. Beale, Jr., Governing Board. The Senior members of the society residing in New Haven were invited to attend the meeting, and they decided to hold two meetings each year in connection with the regular meetings of the Student Branch. E. S. Cooley was elected chairman of this body and E. H. Lockwood, secretary.

MEETING OF THE COUNCIL

A meeting of the Council was held on April 10, at the Society rooms, with the President in the Chair. There were present, Charles Whiting Baker, D. F. Crawford, George M. Brill, R. M. Dixon, James Hartness, Stanley G. Flagg, E. B. Katte, I. E. Moultrop, H. G. Reist, Jesse M. Smith, H. G. Stott, H. H. Vaughan, Wm. H. Wiley and the Secretary. Regrets were received from W. F. M. Goss, A. C. Humphreys, W. J. Sando.

The following deaths were reported: Paul Raymond Brooks, George B. Caldwell, A. L. Hammarberg, F. L. Hart, Everett H. White D. B. Wilson, Charles Wallace Hunt, Past-President.

Jesse M. Smith offered the following resolutions on the death of Charles Wallace Hunt.

Charles Wallace Hunt, Past-President of The American Society of Mechanical Engineers, passed away on March 27, 1911, after twenty-six years of active

and effective service as a member, officer, President and Past-President of the Society; and

Whereas the Council in session after this blow has befallen the Society is desirous to record its sorrow and sense of loss and its sympathy with those to whom this bereavement has come so sorely close;

Be it resolved that the Honorary Secretary be requested to prepare a memorial notice to be published in The Journal with a portrait of Mr. Hunt; and be it further resolved that this minute commemorative of the great and notable services of Mr. Hunt to the Society be similarly published, and a copy of both be transmitted by the Secretary to Mrs. Hunt and the family with expressions of the keen and profound sympathy of Mr. Hunt's friends in the burden in which they are called on to bear.

Voted: That Mr. Smith be appointed a committee to transmit the above resolutions to Mrs. Hunt.

Professor Hutton offered a memorial notice, which appears elsewhere in The Journal.

That the following new By-Law be adopted, the required thirty days' written notice having been given:

> B 23 The Committee on Meetings shall consist of five persons who may be members of any grade. The term of office of one member of the Committee shall expire at the end of each Annual Meeting. It shall be the duty of the Committee to procure professional papers, to pass upon their suitability for presentation, and to suggest topical subjects for discussion at the annual and semi-annual meetings. The Committee may refer any paper presented to the Society to a person or persons, especially qualified by theoretical knowledge or practical experience, for their suggestions or opinions as to the suitability of the paper for presentation. Papers from non-members shall not be accepted except by unanimous vote of the Committee.
>
> The Committee shall arrange the program, and shall have general charge of the entertainments to be provided for the members and guests for the above meetings. It shall prohibit the distribution or exhibition at the headquarters or at the places of the above meetings of all advertising circulars, pamphlets or samples of commercial apparatus or machinery. At the end of each fiscal year, the Committee shall deliver to the Secretary for presentation to the Council, a detailed report of its work.

Voted: To adopt the following new Rule 4:

> Papers accepted by the Committee on Meetings shall be classified as follows:

a Papers valuable for record, but not suitable for presentation at a meeting, which will be referred to the Publication Committee with the recommendations of the Committee on Meetings.

b Papers requiring either advance publication or printing and distribution in pamphlet form, either in full or in abstract for discussion at a meeting.

Papers of this class the Committee on Meetings may either turn over at once to the Publication Committee for advance publication in The Journal if approved by that Committee; or it may have printed in pamphlet form a sufficient number of copies for distribution at a meeting, for mailing in advance to those who may discuss the paper and to others who may desire copies because of publication of the title or an advance abstract of the paper in The Journal.

c Papers which require discussion at a meeting to determine their value and general interest.

Papers of this class may be accepted by the Committee on Meetings, but should not be put in type until they have been read and discussed.

The Committee on Meetings may in its discretion select papers for the annual or semi-annual meetings which have already been presented and discussed before local meetings of the Society.

A member may by letter signify his intention to discuss any of the papers, and unless otherwise directed by the Presiding Officer priority in debate shall be given in the order of the receipt by the Secretary of such notification.

The Committee on Constitution and By-Laws presented amendments to By-Laws 13 and 29, which on motion were approved, due notice having been given:

B 13 The voting for the election of officers shall close at ten o'clock in the forenoon on the first Tuesday in December in each year: The Tellers shall not receive any ballot after the stated time for the closure of the voting. The tellers of Election shall first open and destroy the outer envelopes and shall then open the inner ones, canvass the ballots and certify the result to the President or Presiding Officer at the first session of the current meeting of the Society. The Presiding Officer shall then announce the candidates having the greatest number of votes for their respective offices, and declare them elected for the ensuing year.

B 29 A Nonimating Committee of five members, not members of the Council, shall be appointed by the President within three months after he assumes office. It shall be the duty of this Committee to send to the Secretary, on or before September 15, the names of consenting nominees for the elective offices next falling vacant under the Constitution. Upon the request of any member or Associate, the Secretary shall furnish to the applicant the names of such nominees. The names of the nominees proposed by the Committee shall be published in the next issue of The Journal.

Voted: That Dr. Alex. Humphreys be appointed to represent this Society on the Board of Trustees of the United Engineering Society to serve for a term of three years, filling the unexpired term of the late Charles Wallace Hunt.

H. G. Stott, Chairman of the Committee appointed to coöperate with the National Association of Master Steam and Hot Water Fitters in recommendation of extra heavy steam pipe flanges and fittings, presented a report of action taken in the joint committee, with the schedule of standards.

Voted: That the report be accepted with thanks and be referred to the Committee on Meetings with the recommendation that it be presented at the Spring Meeting.

The President presented a report of action taken by a committee of engineers concerning the pending legislation in Albany advocating the licensing of engineers.

Voted: To approve the appointment by the President of Honorary Vice-Presidents James Christie, J. Sellers Bancroft, J. M. Birkinbine, George W. Melville, James M. Dodge, A. C. Jackson, to attend the annual meeting of the American Academy of Political and Social Science in Philadelphia April 7 and 8.

Voted: To approve the appointment of Honorary Vice-Presidents F. R. Hutton and F. B. Gilbreth, to attend a meeting of the Welfare Section of the National Civic Federation on April 6.

Voted: To confirm approval of the action of the Executive Committee with respect to applicants for membership as approved by the Membership Committee for the Spring Ballot.

Voted: To accept the resignations of T. S. Hamilton, Louisville, Ky., E. S. Barlow, New York, W. M. Peckham, Troy, N. Y.

NECROLOGY

CHARLES WALLACE HUNT

Charles Wallace Hunt, Past-President of The American Society of Mechanical Engineers and of the United Engineering Society, was called to his rest on March 27, 1911, filling to the full his allotted three score and ten years.

He was born at Candor, Tioga County, New York, on October 13, 1841. His early scientific education was begun at Cortland Academy, Homer, New York, but during his life he never ceased to be a student. During the Civil War, Secretary Stanton assigned to him the duty, for which his kindly nature and sound judgment admirably fitted him, of looking after the welfare of the thousands of negroes who flocked into the Union lines from the Southern States. He taught them how to take care of themselves by putting them at work in the mills furnishing supplies for the Government.

Returning from his services to the Government, about 1868, he began his business career on Staten Island, New York, in the storing and handling of coal. It was here that his engineering career began. He realized how slow and expensive the process of handling coal then was and set about to improve it. The result was the development of his automatic railroad, by which the coal was lifted from barges and carried back on an elevated track and dumped automatically at any desired point. This system was later introduced to a large extent, notably at the large coal stations of the Calumet and Hecla mines on Lake Superior, and in many other lake and seaports in this country and abroad. The automatic railway completely solved the problem, and so perfectly that few if any improvements in this particular device have been made since. This work led to the invention of many coal-handling devices.

Later he became interested in the development of the system of chain conveyors running on wheels and having swinging buckets which always remained upright except at the points where they were dumped. This system was very largely and successfully used in many large steam power plants and locomotive coaling stations. By its use coal could be carried horizontally, or vertically, or at any angle, from

any point and delivered automatically and continuously at any one of many other points; and ashes could be collected at many different points and delivered at other points by the same endless conveyor chain with buckets carried on wheels, and kept continuously in motion by an ingenious pushing device that avoided very largely the friction of the ordinary sprocket chain machines, then in common use, which dragged the coal along the bottom of a trough.

A story is told of him by one of his friendly competitors which is both characteristic of the man and vividly brings out the difference in principle of these two systems. The two men were before a committee which had to decide on the purchase of one of the two systems presented. Mr. Hunt said: "If you wished to move a cat from one corner of the room to the other with the least effort and trouble, would you catch it by the tail and drag it across against the resistance of its claws in the carpet, or would you gently lift the cat into a basket and smoothly and easily carry it across?" He got the contract and his competitor enjoyed the story.

His genial humor, coupled with his straight-forward common sense and ability to get at foundation principles, were among his most attractive characteristics.

In connection with his coal-handling machinery, Mr. Hunt was called upon to design and build many large steel structures for the storage of coal in large quantities. These included the coal stations for the United States Navy at Guantanamo, Puget Sound and Manila, as well as other large plants in South Africa, Europe and Australia.

In addition to the large plant of the C. W. Hunt Company on Staten Island, New York, of which he was President, there were plants in England and Germany for the manufacture of machinery designed by him. The development of coal-handling machinery by Mr. Hunt and his associates has reduced the cost of handling coal from about thirty to three cents per ton. He designed machinery for the rapid and economical handling of freight, a notable example being that at the Greenville terminal of the Pennsylvania Railroad.

Another direction in which Mr. Hunt showed his ingenuity and good engineering sense, was in the development of his industrial railway. He adopted a narrow gage of 21½ inches for his tracks, which were made in complete sections ready to be joined together in any desired combination with very short curves and switches and turntables enabling the tracks to be carried anywhere around shops and yards. His cars were made in a great variety of special forms to do special work in the best manner. The wheels of his cars have their flanges on the

outside, contrary to the common practice, for which he claimed great advantage in reducing the resistance of the car on the track and particularly on short curves. He was probably the first to build and use electric storage battery locomotives on very narrow gage railways having very short curves. These locomotives involved special and unusual problems which he showed great ingenuity and skill in solving.

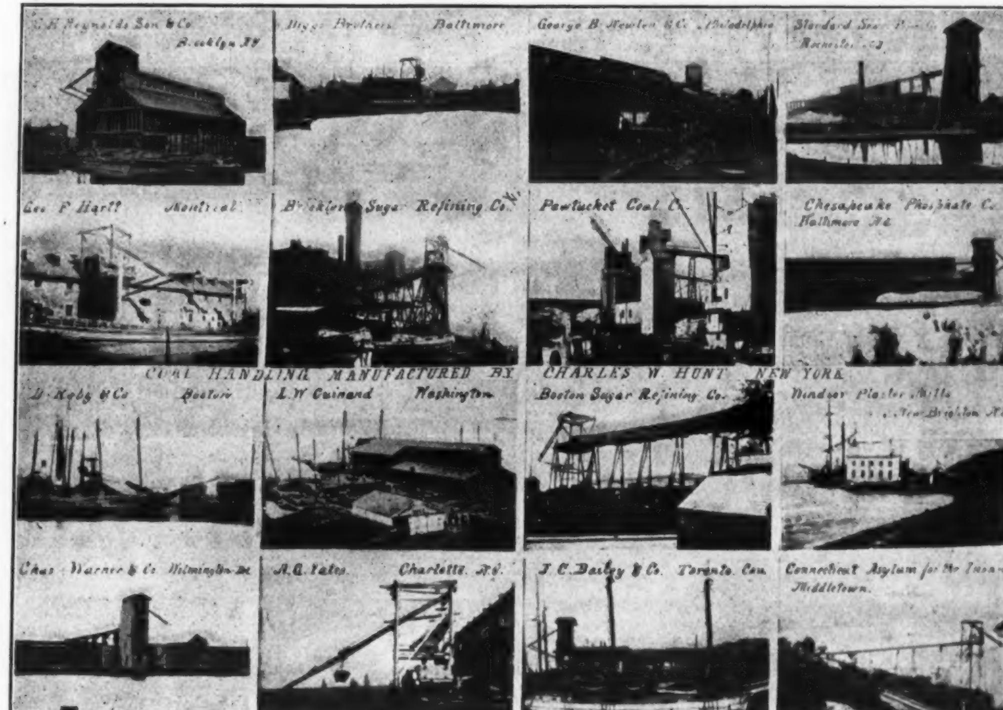
His inventive genius is represented by one hundred and forty-seven patents issued to him and three others which have been allowed.

Mr. Hunt had a deep interest in the profession of engineering and was always ready to devote his time and energy to its advancement. His private interests were always held secondary to his interests in the various Engineering Societies of which he was a member.

He has been a member of The American Society of Mechanical Engineers for 26 years and was elected one of its Vice-Presidents in 1892 and became its President in 1898. He has served on many of its most important committees and his devotion to the work has been manifest in all the large policies adopted by the Society. His most notable committee work was done as Chairman of the Committee appointed by the Council in 1902 to draft a new Constitution and By-Laws. The result of the assiduous work of that Committee, of which he bore the major part, was adopted by the Society in 1904 and then became its organic law. He proposed the policy, incorporated in the Constitution, of putting the various activities of the Society in charge of Standing Committees of five members each, one member retiring and one new member coming on each year, by which a large number of men, devoted to the best interests of the Society have been brought into its active management. He remained Chairman of the Committee on Constitution and By-Laws to the time of his death, and his last work for the Society was done in that Committee on February 17 last. In no place will his broad-minded yet conservative counsel be more great lymissed.

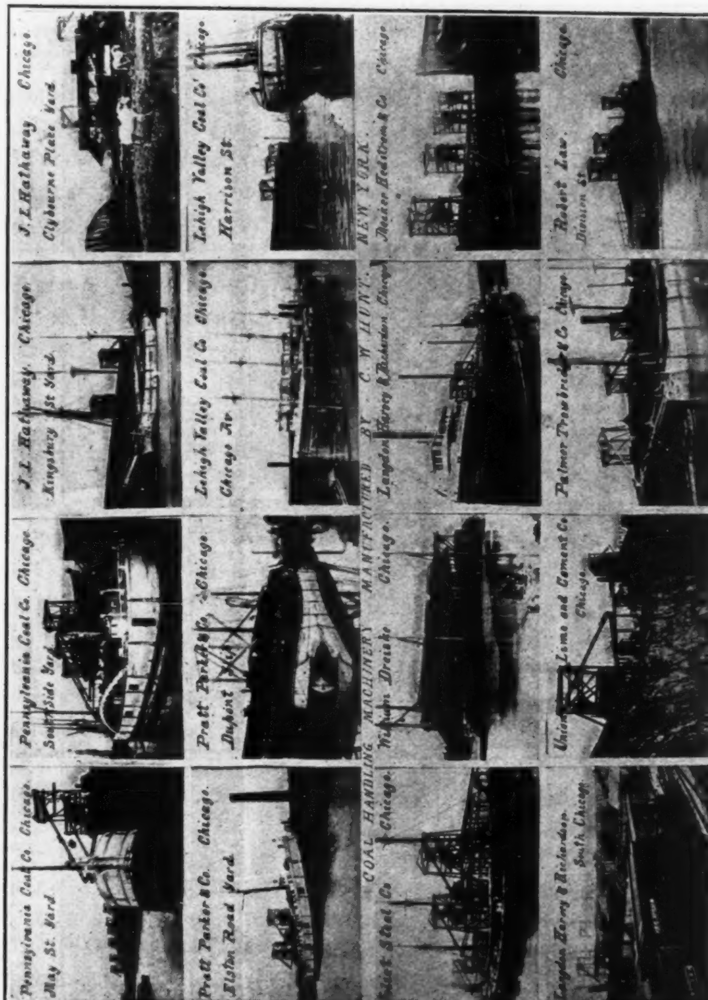
Mr. Hunt ceased to be a statutory member of the Council in 1904 but he, with other Past-Presidents, were invited by the Council to sit at its sessions as Honorary Councilors. Although not obliged to be present, he rarely missed a Council meeting when his health permitted and always gave such sound advice that the members of the Council were wont to show their sincere respect by referring to him as our "Elder Councilor."

Mr. Hunt was also a member of the American Institute of Electrical Engineers; the American Institute of Mining Engineers; the American Society for the Advancement of Science; Franklin Institute;



Some of the Work of Past-President Charles Wallace Hunt

The photographs reproduced on this and the opposite page were submitted by Mr. Hunt with his application for membership in 1885.



Coal and Ore Handling Machinery Designed by Mr. Hunt

He was a pioneer in this field, all of the work shown on these pages having been done prior to election to membership in 1885.

New York Electrical Society; Inventor's Guild; New York Chamber of Commerce; National Geographical Society; Staten Island Association of Arts and Sciences; Staten Island Chamber of Commerce; The Engineers' Club; The Railway Club; The Hardware Club; and The Machinery Club. He was President of the Richmond County Savings Bank.

When Mr. Andrew Carnegie made his notable deed of gift in 1903 to be devoted to a building for the Engineering Societies, Mr.Hunt was promptly chosen as a member to represent The American Society of Mechanical Engineers on the organization committee, and later of the building committee, and finally of the Board of Trustees of the United Engineering Societies. He continued in office during two terms under the principle, which he himself recommended, that no trustee should be immediately eligible at the close of a second term. After a year had elapsed however, he was re-elected to serve in the position which he had so conspicuously adorned. He was at the beginning of his third term when death overtook him. His influence in the Board was conservative, yet progressive. It was his recommendation that no decision of the Building Committee should ever be carried out until the entire Board was unanimous respecting it. That was largely responsible for many well-balanced decisions respecting details of the building and its consequent satisfaction to all parties. Up to the very beginning of his last illness he was active and suggestive respecting certain propositions looking to the development of the library and of an enlargement of its scope and usefulness.

Mr. Hunt served also on many other committees representative of the Society. About a dozen years ago he served as a representative of the Society in formulating a revision of the Building Code of the City of New York to take care of the changes introduced by steel construction and the tall cellular building. He served also on the committee to install the Thurston memorial tablet and was a member of the John Fritz Medal Board. He also served on a committee to write the history of the Society. From time to time he contributed from his experience several valuable papers to the Society.

In his presidential address in December 1898, at the Annual Meeting of that year, Mr. Hunt took as his title, The Engineer, and in that paper, drawing most largely perhaps upon his own philosophy of life, he made this statement, doubtless also the product of his own experience: "The life of an engineer has a full measure of the labors, the trials, the discomforts and the disappointments which are found

in this as in every other walk of life, but—it has also the successes which come from well directed labors. It is not, however, either the useful work in itself, or what are called the successes of life, which bring happiness. It is a man's ideals which make him happy . . . Cheerfully can he enter upon his daily task with the consciousness that his application of these discoveries is of real service in lightening the burdens of our life, as well as elevating and ennobling his fellow men." Such was the story of Mr. Hunt's life and such were his achievements.

Col. E. D. Meier, President of the Society; Prof. F. R. Hutton, Past-President and Honorary Secretary; Henry R. Towne, Past-President; Jesse M. Smith, Past-President; Alex. C. Humphreys, Vice-President; Henry G. Stott, Manager; Charles Kirchhoff, John W. Lieb, Jr., Alfred Noble, W. H. Fletcher, Members; and Calvin W. Rice, Secretary, were appointed Honorary Vice-Presidents to attend the funeral and represent The American Society of Mechanical Engineers. This was held in the Church of the Ascension at West New Brighton, on Thursday, March 30. The body of Mr. Hunt was laid at rest in the beautiful cemetery at New Dorp, Staten Island, New York.

EVERETT HANSON WHITE

Everett Hanson White was born May 26, 1872 at Barre, Mass. He received his early education in the public schools of his native town and in 1888 entered the employ of the Putnam Tool Company, Fitchburg, Mass., taking three years' special training in the shop. He became connected with the Houston Electric Company and later accepted a position with the Wire Goods Company of Worcester, Mass., and with Plummer, Ham and Richardson of the same place. In 1899 he entered the employ of the Locomobile Company of America as draftsman, and at the end of eight months was promoted to the position of chief draftsman at the Bridgeport, Conn. factory where he also had charge of the experimental department. He designed their 1902 Touring Carriages and Worcester engine which developed 7½ h.p. and weighed but 45 lb. In 1903 Mr. White accepted a position with the Eaton, Cole and Burnham Company, of Bridgeport, later controlled by the Crane Valve Company of Chicago, and was then made consulting engineer of the company. In 1905 he entered Sheffield Scientific School of Yale University and completed the four years' course in one year. He died January 12, 1911, at Bridgeport, Conn.

FREDERICK L. HART

Frederick L. Hart died March 23, 1911, at Jamaica, N. Y. He was born July 3, 1861, in Brooklyn, N. Y., and was a graduate of the Polytechnic Institute of that city. He served his apprenticeship of a year and a half at the Columbian Iron Works of Brooklyn and three and a half years at the Wright Steam Engine Works of Newburgh, N. Y. His professional work included the erection of an ochre mill for the Franco-American Mining and Ochre Company of Brooklyn, and the installation and operation of an electric plant for the New York and Brooklyn Bridge. He was connected for a period of four years with the Third Avenue Railroad Company of New York as chief engineer and later in the same capacity with the Tenth Avenue and 125th Street Cable Railroads resigning later to become engineer in charge of the Broadway Railway Company. Here he remained for two years and then became general manager of the Baltimore City Passenger Railway Company a position which he held for six years. Subsequent to this he was associated with the Washington Railway and Electric Company and the Thomas Bashor Company, contracting engineers of Baltimore.

GEORGE B. CALDWELL

George B. Caldwell was born in Lowell, Mass., April 11, 1863. He received his early education in the public schools of Lowell and at the age of seventeen he became an apprentice of the Lawrence Manufacturing Company of Lowell, serving his time in their shops and drafting rooms. At the end of his apprenticeship he remained with the same company as assistant to the master mechanic until 1899, when he accepted the position of master mechanic of the Washington Mills Company, Lawrence, Mass., where for four years he was in charge of their drafting rooms as well as their construction and repair work. In 1893 he entered the employ of Westinghouse, Church, Kerr and Company and retained his connection with this firm until the time of his death, March 31, 1911. During this period he was in responsible charge of designing and constructing many works of engineering interest, among which may be mentioned the mechanical and electrical features of the South Terminal Station, Boston, Mass.; the Pittsburg terminal of the P. & L. E. R. R.; the railroad shops of the P. & L. E. R. R. at McKees Rocks; the construction of the Kingsbridge Power Station of the Third Avenue R. R. He also supervised the design and installation of the Long Island Railroad Company's electrification, including the large power house at Long Island City. His last work was the design and construction of the

mechanical and electrical features of the Pennsylvania Terminal Station in New York City, which he was obliged to relinquish just before it was completed. Mr. Caldwell was also a member of the American Society of Civil Engineers. He was a man of unswerving integrity and of great energy, inspiring perfect confidence and respect in all those with whom he dealt.

ARNDT L. HAMMARBERG

Arndt L. Hammarberg was born October 4, 1862, in Gothenberg, Sweden, and received his technical education at the Chalmers Technical Institute, Gothenberg, from which he was graduated in 1881. His early experience was obtained with the Bergsund Shipbuilding Company, at Stockholm, and as designer and draftsman with the Donnarvest Iron and Steel Works. In 1889 he came to the United States to take a position with the Illinois Steel Company, remaining until 1891 when he entered the employ of the Homestead Steel Works. In the following year he was placed in charge of the rolling mill construction of the Morgan Construction Company, Worcester, Mass., and between the years 1895 to 1898 was successively connected with Julian Kennedy and with Mackintosh, Hemphill & Company, Pittsburgh, Pa., and with the Lloyd Booth Company of Youngstown, Ohio. In 1898 he entered the employ of the Wellman-Seaver Engineering Company, at Cleveland, as chief engineer, leaving there to become chief engineer in 1900 of the Ensley Steel Works, and in 1902 of the Youngstown Sheet and Tube Company. In 1907 he returned to Sweden, and until the time of his death on February 7, 1911, was employed as chief engineer at the Bergsund Shipbuilding Company at Falun.

DWIGHT B. WILSON

Col. Dwight B. Wilson, who died at Denver, Colo., on March 7, 1911, was born at Lewiston, Me., on May 5, 1848, and received his techincal education at the Holmes Commercial School in Boston, Mass. During the Civil War he served under General B. F. Butler as a private. In 1880 he removed to Colorado where he engaged in construction work, and in 1895 was appointed commissioner of highways in Denver. In 1899 he entered the employ of the Denver City Tramway Company, as superintendent of power. One of his notable achievements during the twelve years of his service was the erection of a new power station costing $1,500,000.

Mr. Wilson was a member of the National Association of Stationary Engineers.

THE PROCESS OF ASSEMBLING A SMALL AND INTRICATE MACHINE

By Halcolm Ellis

ABSTRACT OF PAPER

The Ellis adding-typewriter is a combination typewriter and adding machine composed of about 3400 pieces. To secure rapid and economical assembling of such a large number of parts a very elaborate system is necessary. Not only is the machine designed to be assembled in sections, but some of these sections are divided into sub-sections, small groups of assembled parts, assembled parts and individual pieces, all of which are numbered. All the parts are produced by means of carefully made dies, jigs and fixtures so as to be interchangeable without special fitting. During the manufacture of the various parts a record is kept of the successive operations on each one, so that it is possible to tell at a glance what stage each piece has reached at a given time. The sheet on which these records are kept is called the operation docket. When a stock of parts has been produced, each section and sub-section is assembled independently by means of assembling charts and photographs of the parts required for each section. Numerous illustrations show the method employed and various stages of the work from the production of the parts to the completed machine.

O.K.

THE PROCESS OF ASSEMBLING A SMALL AND INTRICATE MACHINE

By Halcolm Ellis,[1] Newark, N. J.

Non-Member

The machine here described is little larger than an ordinary typewriter, but the number of parts is greater and the mechanisms included within it are much more complicated. It is known as the Ellis Adding-Typewriter, and is composed of about 3400 pieces assembled in

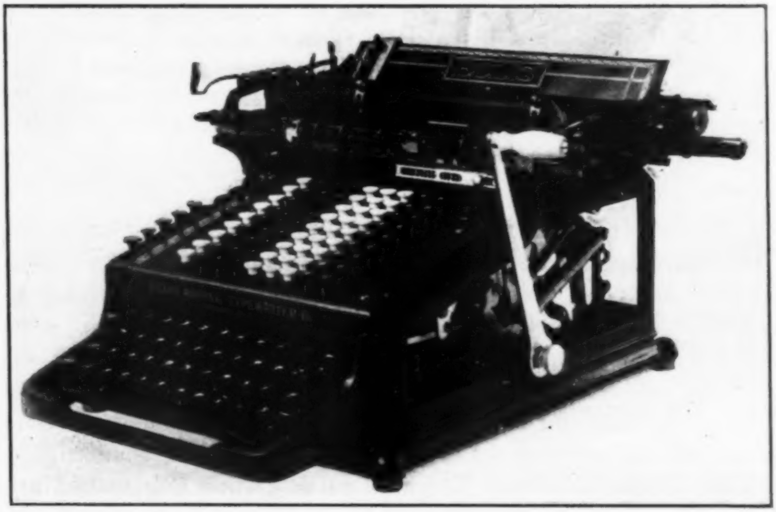


Fig. 1 The Ellis Adding-Typewriter with Glass Sides Removed

various ways. Before taking up the question of the assembling, it may be well to give a brief description of the machine itself and what it will do.

[1] General Manager, Ellis Adding-Typewriter Co., Newark, N. J.

The American Society of Mechanical Engineers, 29 West 39th Street, New York. All papers are subject to revision.

2 The machine (Fig. 1) is primarily a typewriter, and includes all of the elements which go to make up any other standard form of visible printing typewriter. It is provided with a universal keyboard having 42 keys, shift-keys for capitals and signals, tabulating devices and keys for operating them, automatic ribbon movement and ribbon reverse, a device for using a bi-chrome ribbon, thereby enabling the operator to do the printing in two different colors, and a large number of little mechanical conveniences for helping the operator in a speedy execution of his work.

3 Also incorporated in the machine is a complete adding and listing machine, provided with a keyboard containing 81 numeral keys for the setting up of numbers to be added and nine operation keys for setting the machine to perform the different operations of calculation for which it is designed. The adding mechanism controls its own printing device for the printing of numbers, and all totals and sub-totals or other results of arithmetical computations are printed automatically on this machine. The typewriting type and the adding type print on the same horizontal line, and the printing from both is entirely visible.

DESIGNING THE MACHINE TO SECURE RAPID ASSEMBLY

4 The need of a very definite system in the designing of a machine of this character, in order that it may be assembled at all, is evident, and it is also clear that it would be a commercial impossibility to assemble it as a whole, i.e., if each machine were to be built up, piece by piece, by the same man. The solution of the assembling problem lay in the sub-division of assembling and this was accomplished by dividing the machine into sections. These sections in turn were divided into sub-sections, small groups of assembled parts, assembled parts and individual pieces. The machine as a whole was divided into 16 sections, and each section was given a letter; then in order to keep the symbol numbers in order the individual parts were numbered according to the following schedule:

SECTIONS OF ELLIS ADDING-TYPEWRITER

A = Accumulator Mechanism.
B = Base, Frames, Case, Spring Barrel, Carriage Ways.
C = Carriage.
D = Left-hand Operating Parts, Governor.
E = Escapement.

F = Tabulating Mechanism and Bell, and Line Lock.
H = Holder for Paper Roll.
I = Ink Mechanism.
K = Keyboard and Parts for Adding Mechanism.
L = Left-hand Controlling Parts.
O = Operating Handle, Shafts and Parts connected therewith.
P = Printing Mechanism.
R = Reducer or Concentrator Shaft and Parts.
S = Shifting Part of Carriage.
T = Typewriter Parts.

SUB-DIVISION OF EACH SECTION

0–9 Shafts.
10–29 Studs, Pins and Screws.
30–44 Collars (screw machine parts having holes).
45–49 Castings.
50–74 Punched Parts.
75–79 Drop Forgings.
80–89 Springs.
90–99 Miscellaneous parts not in above classification.

A general system was also required in the designing of the machine itself in addition to the numbering of the individual parts. Iron castings were determined upon to form the bases and the main frames on which the other parts are mounted. Most of the latter are made of sheet-metal punchings, combined with and suspended on screw machine parts, and so mounted on the iron castings. Each section of the machine was designed to be, so far as possible, a complete working unit, interchangeable on different machines. Each section was arranged to have the fewest possible points of connection to the operating means, since it is easier to obtain synchronism where the motive power is derived from a single source rather than from a plurality of sources.

5 Next there was the grouping of members and parts for similar functions. This grouping is of twofold advantage. In some cases it is of material benefit to the operator of the machine, and in other cases of benefit to the assembler in putting the machine together. The necessity for this grouping and segregation of parts is almost as great in a machine of this kind as in a department store, where it is easy to imagine the confusion that would result if the store were maintained and all the departments abolished. In consequence of this grouping the typewriter keys are entirely separate from the adding machine keys, the operation keys of the adding machine are in a single column on the left-hand side of the adding machine keyboard, the adding

machine tabulating key on the adding machine keyboard, and the typewriter tabulating key is with the typewriter keys.

6 Regarding the inside of the machine it can be said that all shafts which have a constant motion when the handle of the adding machine is operated are controlled by the mechanism on the right-hand side of the machine, while shafts which have an irregular movement in relation to the handle movement are controlled by the mechanism on the left-hand side of the machine.

7 The adding machine itself is mounted on two vertical cast-iron side frames extending longitudinally of the machine. The parts between the two frames are primarily for executing the work of calculation and printing, while the parts on the outside of the two frames are for determining and directing the operation of the parts between the frames.

8 These facts may not seem to have much bearing on the problem of assembling the machine itself, but they are of extreme importance in this connection. By knowing the location of the parts which do the work the assembler is assisted in inspecting the work as he goes along and is instantly enabled to locate troubles and faults. If the machine were designed without this separation of functions it would be very difficult indeed to determine just what the trouble might be in many cases where the parts are out of sight.

9 There are many other limitations in the designing of a machine of this character, such as the convenience of the machine to the operator, so as to enable him to attain speed in the execution of his work; the character of the parts and the method of producing them, such as punchings, screw machine parts, castings, etc., and the means of machining and finishing these parts so that they can be used interchangeably. Esthetic considerations must be applied to determine the size, form, color and finish of surface, ornamentation, etc., of the machine as a whole. Also, the assembling and operation requirements call for consideration in the design. These include the limitations of the materials in strength, lightness, hardness, elasticity, etc.; the allowance of clearance to correct errors due to distortion; the spring of parts; the effect of rebound and means of overcoming it; irregularities in castings and in the machining of parts; changes due to variation in temperature, etc. These are some of the points which, if carefully considered by the designer, help somewhat in the ultimate assembling of the machine, and if neglected arise spectre-like to worry the maker afterwards.

THE PRODUCTION OF PARTS

10 System in designing is the first step in the assembling; the second step is the accurate production of individual parts and the accurate assembling of small groups of these parts. In general, the parts in this machine are of three kinds: punchings, screw machine parts, and castings. The latter have various machine operations on them.

11 The punchings of which this machine is mainly composed, are all produced from dies similar to that shown in Fig. 2, and

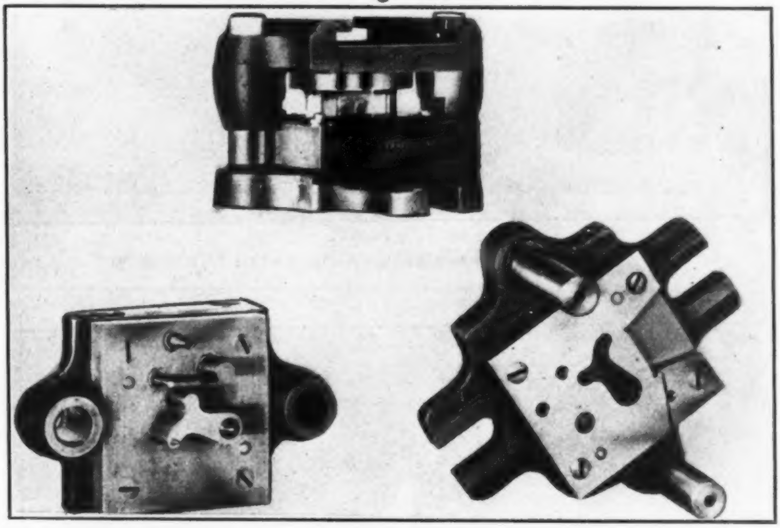


FIG. 2 TYPICAL BLANKING DIE

are, properly speaking, sub-press dies. The work, however, is not returned into the stock as in many forms of sub-press work, but passes through the orifice in the bottom of the lower bolster. Over 400 dies of this general character are required, and the component parts were made of standard sizes and in considerable quantities. The bolsters and caps were planed or milled in good-sized lots and then drilled and reamed for the guide posts, which were ground to size in lots. The stock parts for the dies, strippers and punch holders were also made up in quantities of standard size, carefully ground top and bottom, and the die stock was labeled with the brand of steel and blued for the layout. There were, of course, a number of standard sizes of stock sub-

presses. The punch stock was not made in standard sizes but was cut special in each case.

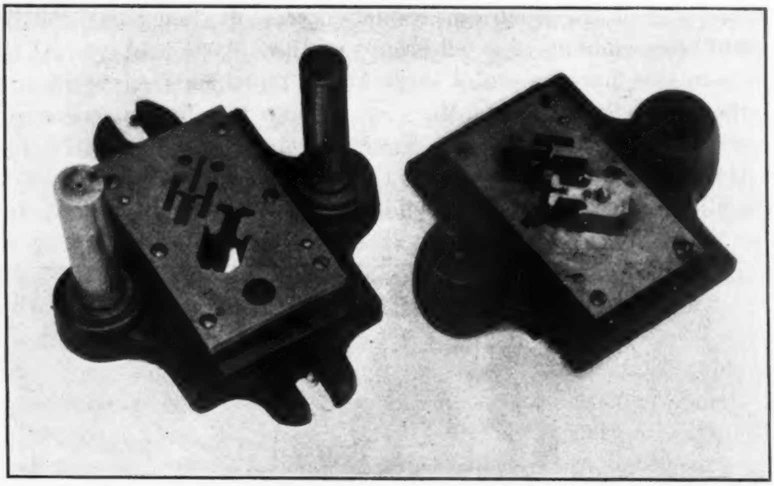


FIG. 3 TWO-STEP PROGRESSIVE BLANKING DIE FOR 50 I

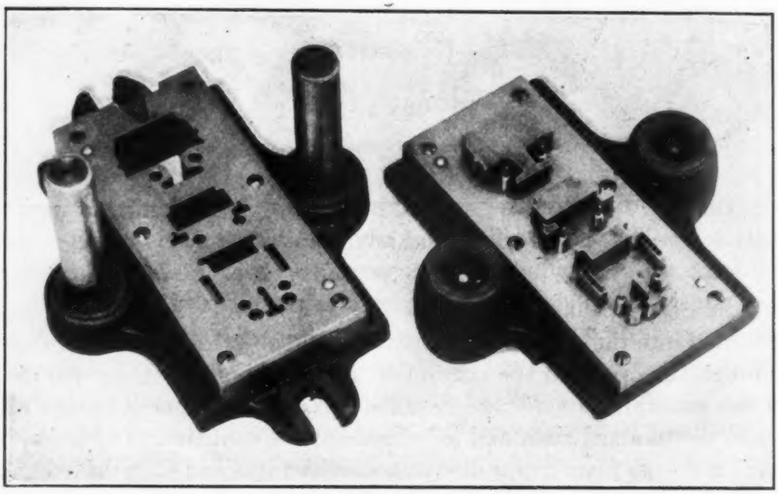


FIG. 4 THREE-STEP PROGRESSIVE BLANKING DIE FOR 51 I

12 While the great majority of punching dies are of this simple kind, there are also many others much more complicated, as shown in

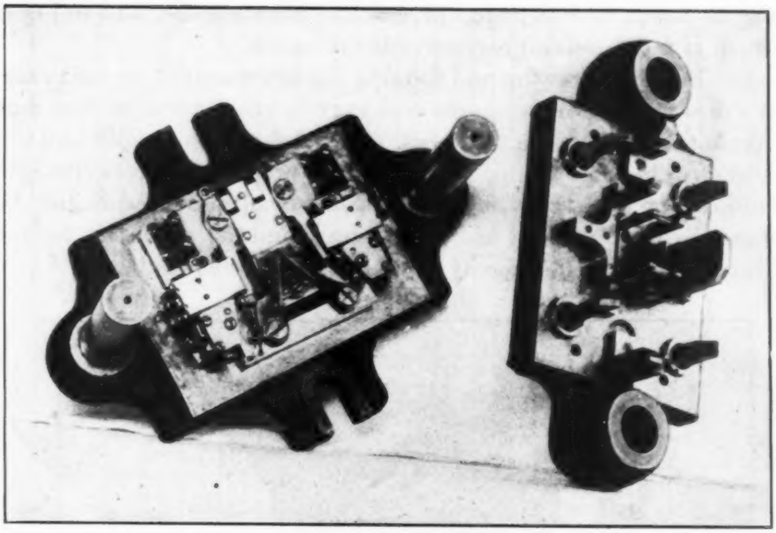


Fig. 5 Forming Die for 50 I

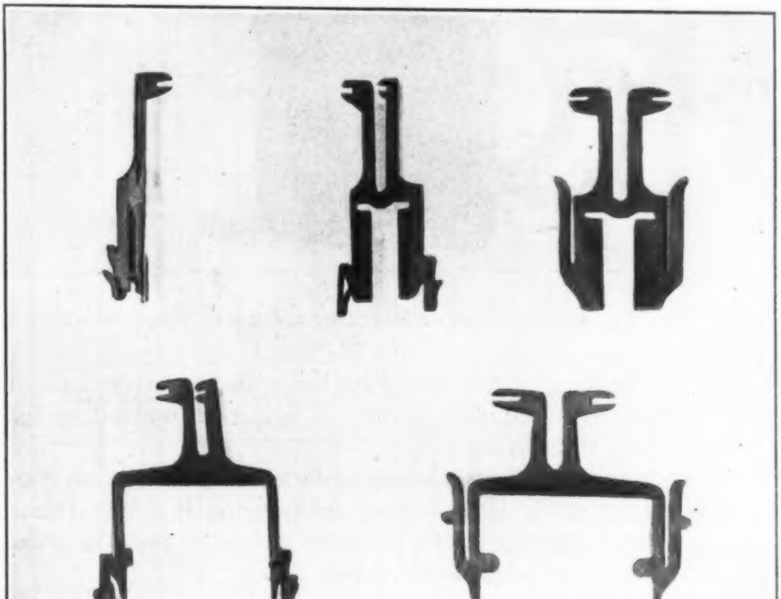


Fig. 6 Ribbon Vibrators 51 I and 50 I

Fig. 3, which is a two-step progressive blanking die, and in Fig. 4, which is a three-step progressive blanking die.

13 Bending, drawing and forming dies are mounted, in most cases, in the same type of sub-press and vary in character from the most simple to quite complicated ones. One of the more complicated dies is shown in Fig. 5, and the piece it produces, in the flat and finished shape, in Fig. 6. The flat blanks being produced in the dies shown in Figs. 3 and 4 are the ribbon vibrators, which are entirely bent to the finished shape by one operation of the bending die.

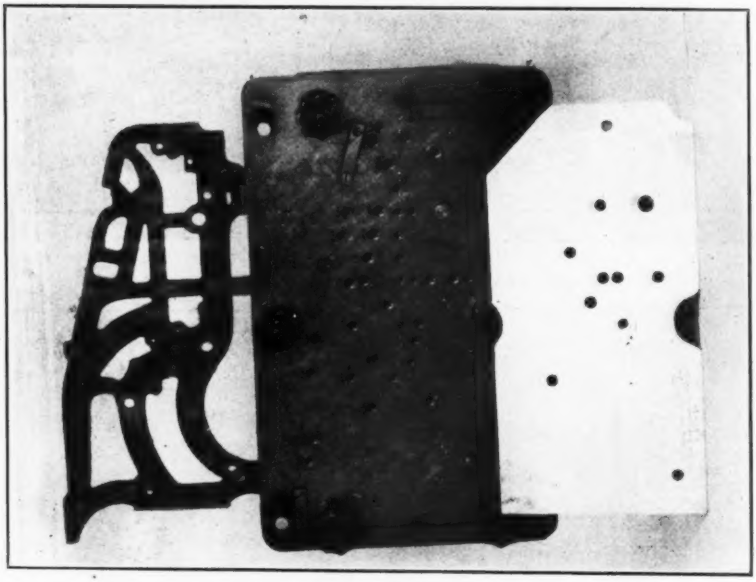


Fig. 7 Left Side Frame B47, Drill Jig and Mask Plate

14 The making of the dies, together with the other tools for this machine, required the services of about 40 toolmakers for a period of over three years.

15 A few of the screw machine parts are finished on turret forming machines, but most of them are made on Brown and Sharpe automatic screw machines, the processes and tools being in no way different from those generally employed.

16 The castings are the most complicated pieces in the machine, but an effort has been made to keep the machine operations on them as simple and straight as possible. As an illustration, the side frames

Lot. No. .... For .... Machines

SYMBOL	No. of Operations	OPERATIONS																				FINISHED	SYMBOL	
		1st		2nd		3rd		4th		5th		6th		7th		8th		9th		10th				
		S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F			

FIG. 8 OPERATION DOCKET
The sheet actually used provides for twenty operations.

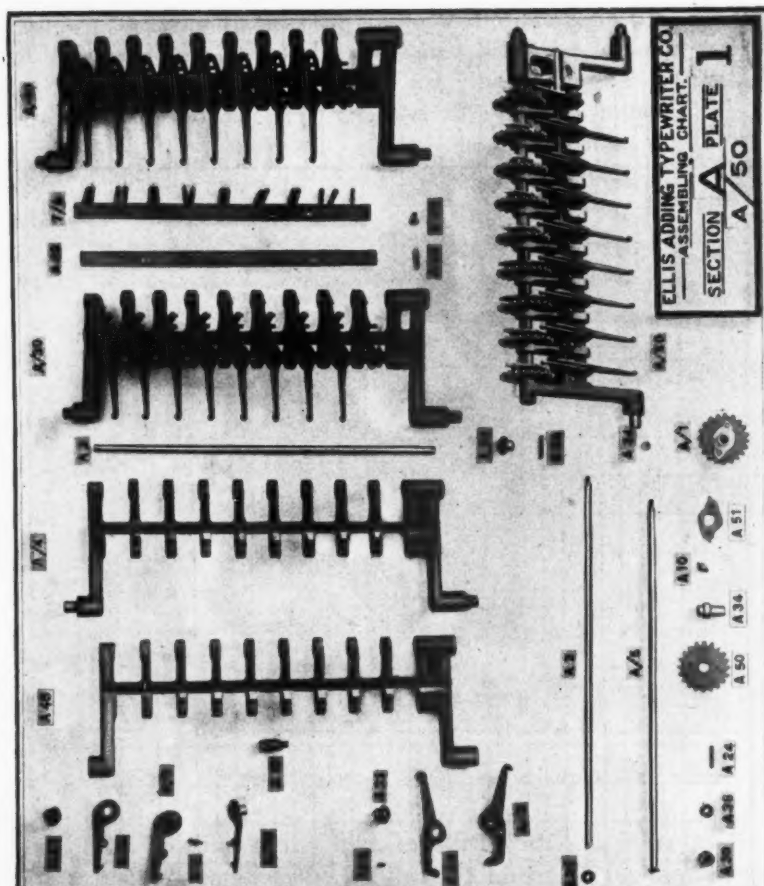


Fig. 9 Assembling Chart for Sub-Section A/50

B 46 and B 47 (see Fig. 7) are of uniform thickness through all flanges and bosses. These castings have an allowance of only 1 mm. in thickness for finish on the two sides. They are straightened in a press, after being heated, and are then japanned. Following this they are ground to size on Pratt and Whitney vertical surface grinding machines at the rate of about five minutes per pair. No difficulty is experienced in bringing the two sides of these frames perfectly flat and parallel, with a variation in thickness not over 0.01 mm. After the frames are ground, they are drilled and milled. The left-hand frame, B 47, has 61 holes through it, requiring over 200 operations. The master plate from which the drill jig was made required about 70 days' time of the most expert workmen. The resultant plate contains 66 holes true to drawing within 0.01 mm. As an illustration of the effect of this kind of work on a man, it might be mentioned that after about 30 days' work it was discovered that the workman had made a mistake in his calculations which put about 20 of the holes 0.1 mm. wrong, and the discovery, made by the man himself, so unnerved him that he broke down and wept and had to stop work for the day to recover himself.

17 Stock records of the manufactured parts of this machine are kept on typical card forms adapted to the peculiar requirements of this machine. The operation card, perpetual inventory, and stock order forms are too well known to be shown; but the form called the docket (Fig. 8), which shows the progress of the work on every piece during the progress of a lot of machines, may be of interest. By turning over the pages of this docket, it can be seen at a glance what work has been done and what remains to be done on every individual piece composing the machine; how long it has taken to do the work; and, by referring to back entries, how long it will take to finish the work. This form is much more visible than any card index system, and is correspondingly more useful to the foremen and superintendents.

ASSEMBLING THE SECTIONS OF THE MACHINE

18 The assembling of the machines is first done by building up what are known as sections, after which the sections are connected to form a complete machine. The growth of a single section will be illustrated by showing how the parts in the A section come together. This section is located at the rear of the machine. It consists of two entirely separate and independent adding mechanisms

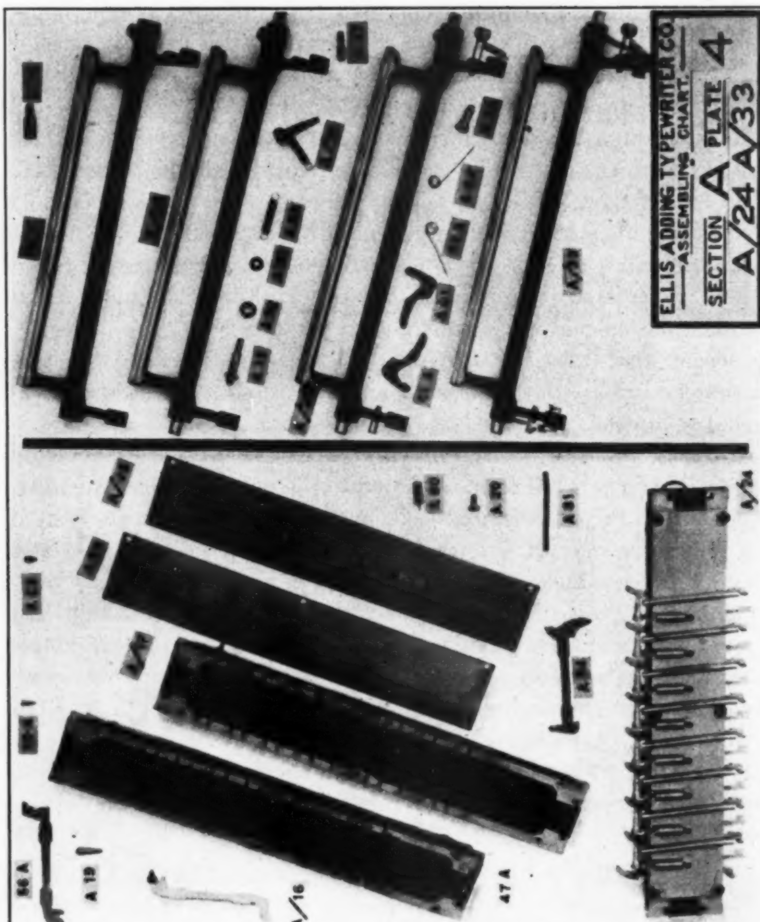


Fig. 10 Assembling Chart for Sub-Sections A/24 and A/33

14

B/30	B/60	L32'										
CT'D	CT'D	L20'										
		83L'										
		L/7^2	L56'									
			L18'									
			L21'									
		L32^2										
		L20^2										
		82L'										
		81L'										
		T84^2										
		A/60'	A/50'	A/1^3	A50'							
					A51'							
					A10^2							
					A34'							
				A/40'	A/30'	A/20^3	A/2'	A52'				
								A33'				
							A18'					
						A/3^6	A53'					
							12A'					
							A33'					
						A/4'	A48'					
							A16^2					
						A3'						
						A33'						
						A24'						
					A60'							
					A29^2							
					A82^7							
				A/5'	A2'							
					A36'							
				A30^2								
				A36'								
				A24'								
				A35'								
			A/21'	A/6^8	A56'							
					A19'							
				A/7'	A47'							
					10A'							
				A/8'	A58'							
					A22^8							
				A54^3								
				A20^4								
				A80^8								
				A81^8								
			A/31'	A/22'	A/9'	A49'						
						A16^2						
					A17'							
					A/10'	A15'						
						A32'						
						A36'						
						A83'						
				61A'								
				A61'								
				A11^2								
				A84'								
				84A'								

Fig. 11 Typical Sheet from Assembling Chart

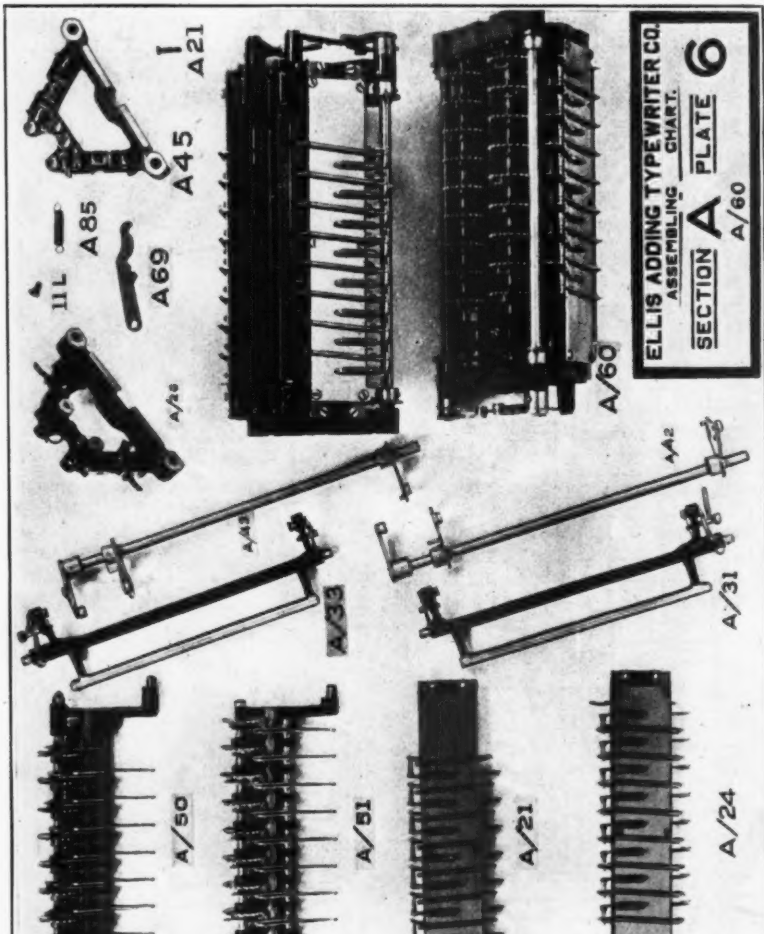


FIG. 12 ASSEMBLING CHART FOR SUB-SECTION A/60.

mounted in a single frame, each being controlled by a single connecting bar from the operating mechanism of the machine, as shown in Fig. 1. The individual parts that compose section A are assembled as

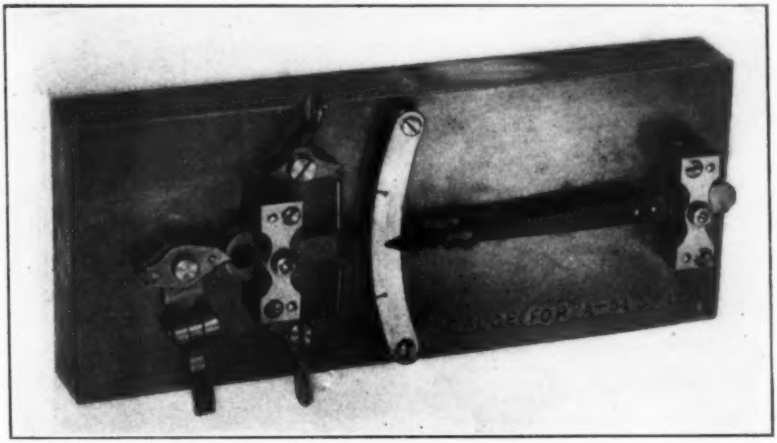


Fig. 13 Test Gage for A 51 and 51 A

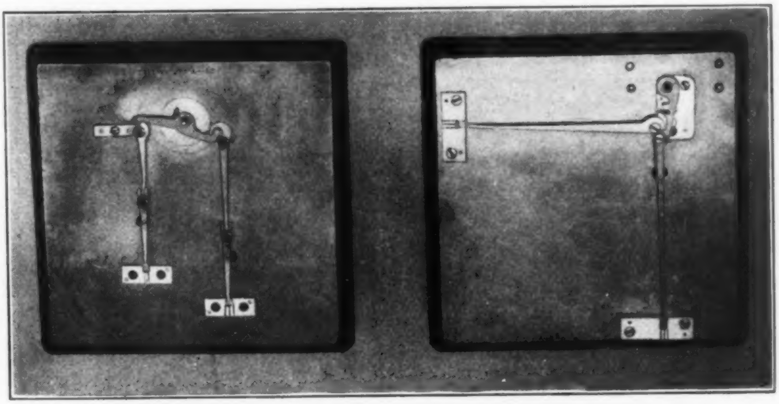


Fig. 14 Typical Test Gages

shown in Fig. 9. Here a series of parts are shown in progressive steps, from the original machine pieces up to sub-section A/50.

19 **A** 33 and **A** 52 combine to make A/2, to which is added **A** 18, making A/20. In the same way 12 A, A 33 and A 53 are assembled, making A/3. Two screws, A 16, are inserted in the ends of **A** 48, mak-

ing A/4. The shaft A 3 is inserted through a series of holes in A/4, and as it is inserted eight pieces A/3 and nine pieces A /20 are strung

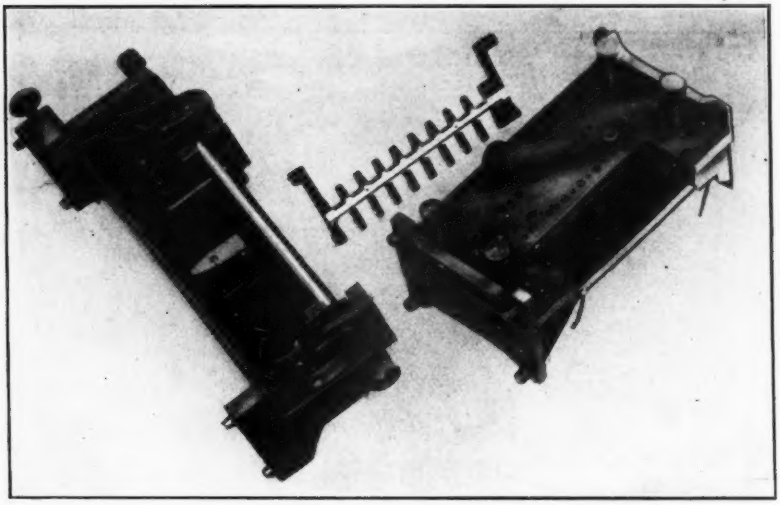


FIG. 15 ASSEMBLING DRILL JIG AND DRILL JIG FOR A 48 AND 48 A

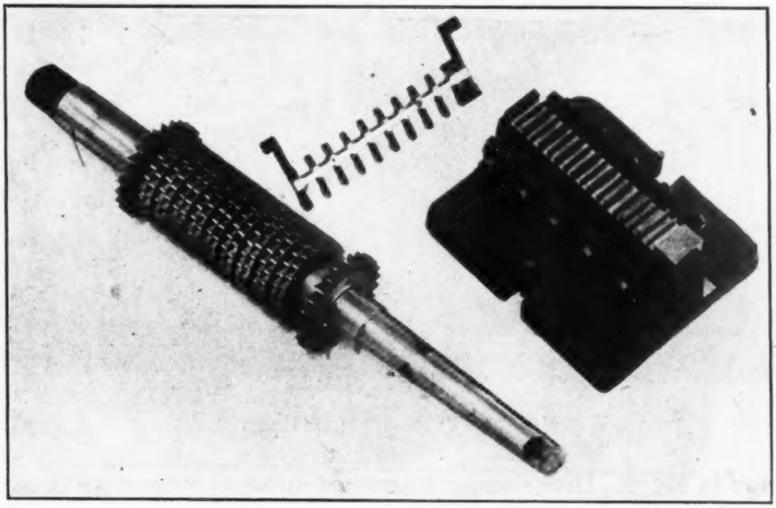


FIG. 16 MILLING FIXTURES AND GANG CUTTERS FOR A 48 AND 48 A

upon it, making A/30. Next a perforated strip A 60 has a series of springs A 82 connected to it, making 7/A, which is mounted on A 30

by screws A 29, and the springs A 82 are connected at their free ends to the small pins 12 A of the pieces A/3. There are nine pieces A/20

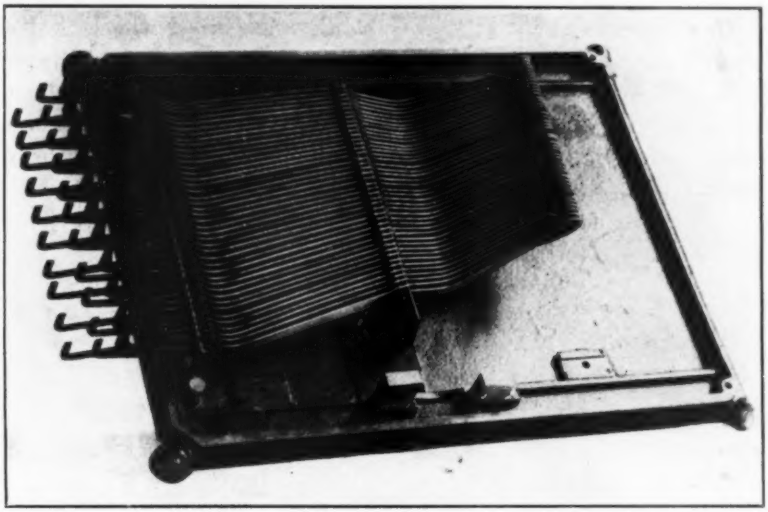


FIG. 17 SECTION B/30

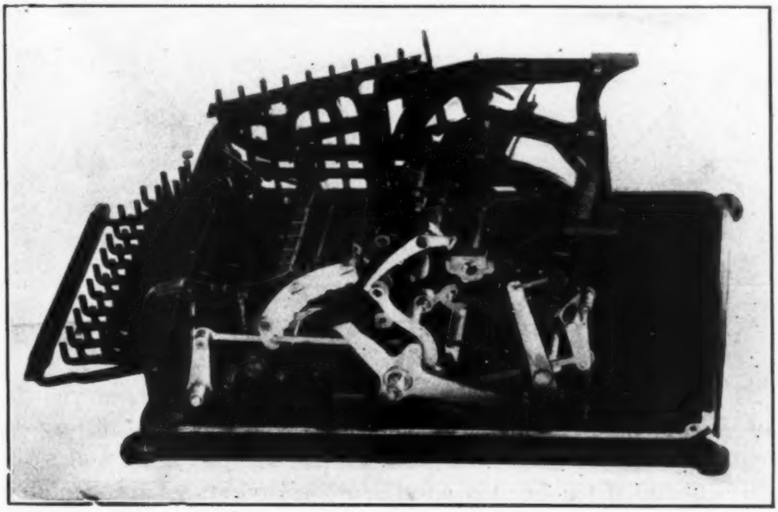


FIG. 18 SECTION B/50—FIRST OPERATION

employed and to fill up the gap which would otherwise be occupied by the piece A/3, an extra hub A 33 is inserted in the space between

the piece A/20 and the side of A 48. In the same way the adding wheels A 50, their side carrying cams A 51, are mounted on the hubs A 34 and secured by rivets A 10, forming a piece A/1, and a suitable bearing rod A/5 serves as a pivot about which these wheels A/1 can revolve, shaft A/5 being inserted through holes in the end of the piece A/40. When these wheels are mounted on the shaft A/5, in the section A/40, the piece is complete and becomes A/50. This is known as a sub-section, which is a complete unit in itself, but goes to form a main section.

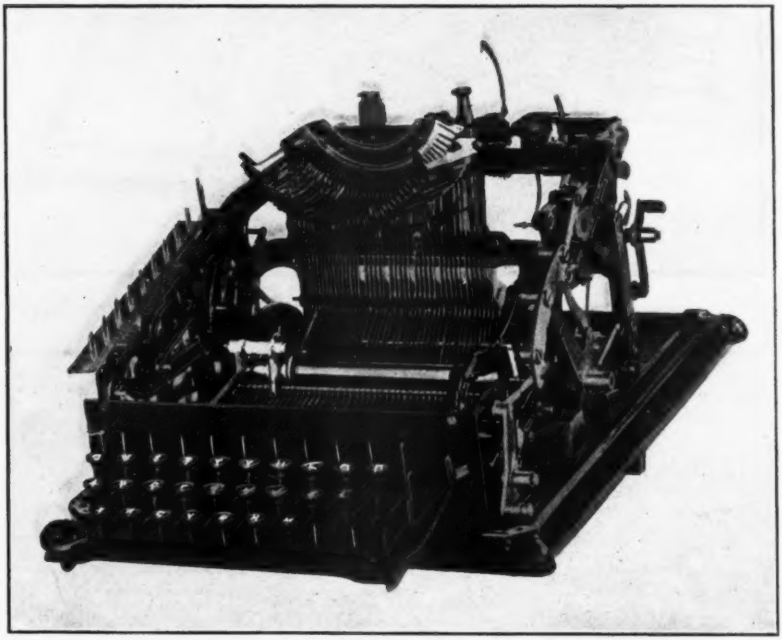


Fig. 19 Section B/50—Second Operation

20 There are two complete and independent adding devices in this machine, made right-handed and left-handed, not in all respects identical. Fig. 10 shows the parts for sub-sections A/24 and A/33, to be assembled left-handed, and the progressive stages in assembling.

21 This method of illustrating the different steps in the assembling and the use of charts (Fig. 11) to simplify the explanation to the workmen is found very useful. It has not come within the writer's experience to find a man capable of carrying this mass of detail in his head

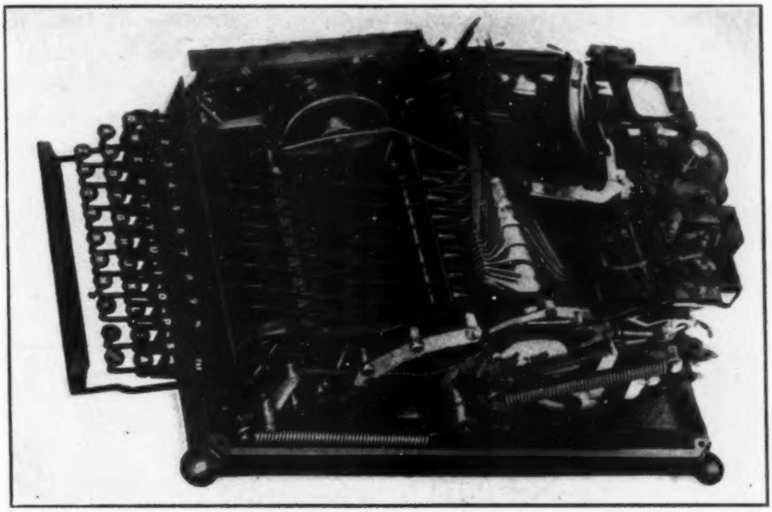


FIG. 20 SECTION B/50—THIRD OPERATION

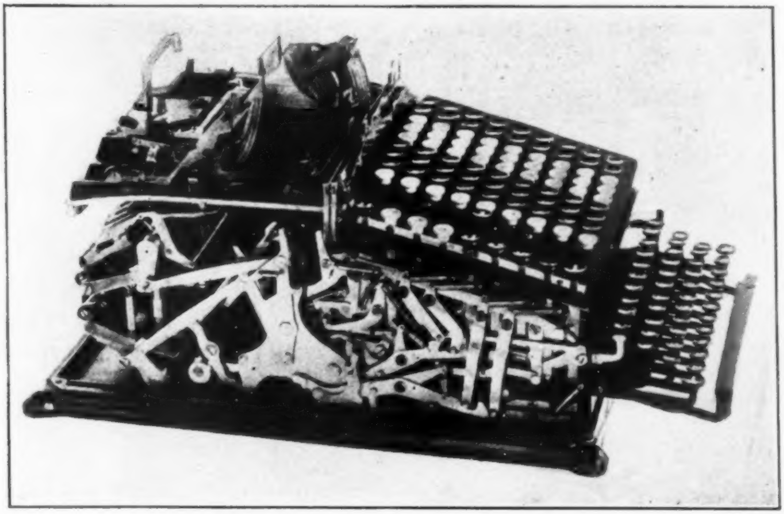


FIG. 21 SECTION B/60—VIEW OF LEFT-HAND SIDE

unless aided by the best memorandum system that can be devised. Of such methods the photographic chart system is the most comprehensive that the writer has so far considered.

22 After the sub-sections are assembled, they are gathered together as shown in Fig. 12, and this forms a complete working unit known as a section. This unit is interchangeable on different machines and can be detached by the removal of six screws. The other individual sections of this machine are assembled in the same general way.

23 Some of the details of the production of the individual pieces, and the assembling of these pieces are shown. The testing gage for the pieces A 51 and 51 A is shown in Fig. 13. This is a compound-lever testing gage which magnifies the reading 100 times, and the error is 0.01 of the space indicated on the dial by the pointer. Other

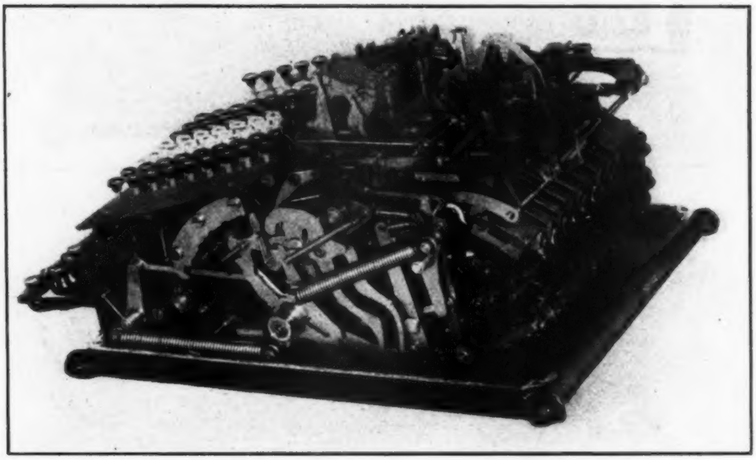


Fig. 22 Section B/60—View of Right Hand Side

test gages, simple and compound, are shown in Fig. 14. In Fig. 15 is shown an assembling drill jig, and a drill jig for the pieces 48 A. In Fig. 16 is shown a milling fixture for the piece A 48 and 48 A and a typical gang mill.

ASSEMBLING THE COMPLETED MACHINE

24 The assembling of a completed machine starts with the base, on which are mounted the typewriter key levers, as shown in Fig. 17. The next step is to mount the two side frames B 46 and B 47 thereon, after which the parts between the side frames are inserted, and connected to the side frames, Fig. 18. The escapement, known as the E/60 section, is next mounted on the side frames, the typewriter connec-

tions are put in, and the machine assumes the appearance indicated in Fig. 19. The next step in assembling is the insertion of the R section or parts, consisting of the racks, the reducer arms, and the governor, all of which are shown in Fig. 20. The next two sections to be inserted are the F/70 section, and the P/70 or printing section of the adding machine. There remain the K and A sections, which are easily and quickly connected. The machine then assumes the appearance shown in Figs. 21 and 22, and is ready to have the case fitted over it and to have the carriage mounted upon it.

25 It may sound rather platitudinous to remark that the mechanical and commercial possibility of the manufacture of a machine of this kind resolves itself into a question of system; not so much a system in the putting of the parts together as the system required in designing the machine in the first place so that the assembling can be properly sub-divided and each section tested for its ultimate fitness in the complete machine.

THE PRESSURE-TEMPERATURE RELATIONS OF SATURATED STEAM

By Lionel S. Marks

ABSTRACT OF PAPER

There has been great uncertainty as to the pressure-temperature relations of saturated steam in the range from 400 deg. fahr. to the critical temperature, owing to the considerable differences between the observations of different investigators. The new and authoritative work of Holborn and Baumann appears to have covered this range with great accuracy; their results are consequently presented to the Society.

With this new material the pressure-temperature relations of saturated steam are established satisfactorily from 32 deg. fahr. up to the critical temperature. It is found that these relations can be expressed by an equation of simple form based upon Van der Waals equation of corresponding states. The values of the pressure derived from this equation have a maximum difference from the best experimental values of about $\frac{1}{10}$ of one per cent in the range from 212 deg. fahr. to the critical temperature (706.1 deg. fahr); below 212 deg. fahr. the maximum difference is 0.196 per cent at 50 deg. fahr. corresponding to a pressure difference of 0.00035 lb. per sq. in.

THE PRESSURE-TEMPERATURE RELATIONS OF SATURATED STEAM

By Lionel S. Marks, Cambridge, Mass.
Member of the Society

The relation between the pressure and temperature of saturated steam is known with great accuracy for the range of temperatures from 32 deg. to 400 deg. fahr., or for the approximately corresponding pressure range from 0.1 lb. to 250 lb. per sq. in. abs. Within that range the experimental values of Regnault and of other investigators agree very closely with the recent and authoritative work of Scheel and Heuse[1] and of Holborn and Henning.[2] It is probable that the temperature corresponding to any pressure within that range is now known accurately to within $\frac{1}{20}$ deg. fahr.

2 At higher pressures and temperatures there is no such agreement between the results of different investigations. Until the past year the most important work in this part of the field had been done by Battelli, by Cailletet and Colardeau and by Knipp. Table 1 (from Marks and Davis' Steam Tables, p. 95) shows the very considerable divergence between the results obtained by these three investigations, particularly at the higher temperatures.

TABLE 1 PRESSURE OF SATURATED STEAM AT HIGH TEMPERATURES

Temperature, Deg. Fahr.	Pressures in Atmosphere according to		
	Battelli	Cailletet and Colardeau	Knipp
400	16.8	16.8	.....
500	48.6	46.6	47.1
600	109.7	107.1	112.5
680	186.7	189.0	207.7

[1]Annalen der Physik, 1910, vol. 31, pp. 715-735. The range covered was from 32 deg. to 122 deg. fahr.

[2]Annalen der Physik, 1908, vol. 25, pp. 833-883. The range covered was from 122 deg. to 400 deg. fahr.

The American Society of Mechanical Engineers, 29 West 39th Street, New York. All papers are subject to revision.

3 During the past year there have been published[1] the results of an investigation carried out at the Reichsanstalt by Holborn and Baumann on the pressure-temperature relations of saturated steam from 400 deg. fahr. to the critical temperature. Considerable weight must certainly be given to any investigation coming from that source and in this particular case, all the internal evidence would indicate that more weight should be given to these results than to those of any of the previous investigators. Of the earlier investigations, the internal evidence clearly indicated that the work of Cailletet and Colardeau was probably the most accurate and for that reason their results have been adopted in recent steam tables. The new values by Holborn and Baumann differ markedly from the values obtained from the three earlier investigations, but are much closer to the values of Cailletet and Colardeau than to the others. It seems worth while to describe briefly the methods and results of this new work.

4 The measurement of vapor pressure may be either by the statical or the dynamical method. In the statical method the liquid and its vapor are maintained at constant temperature and the corresponding pressure is measured. The simplest example of the statical method is that used by Regnault in his experiments with low-pressure steam. For this work the liquid was inserted above the mercury in a barometer tube, the upper part of which was kept in a constant temperature bath; the depression of the mercury column measured the vapor pressure corresponding to the temperature of the bath. In the dynamical method the pressure is kept constant and the corresponding temperature measured. The pressure is maintained by air or other gas acting on top of the liquid, the liquid is heated continuously, and the vapor which forms is condensed continuously and is returned by gravity. The process is similar to that customarily employed for the determination of boiling points at atmospheric pressure, an artificial atmosphere of any desired pressure being maintained over the liquid.

5 The work of Holborn and Henning on saturation pressures from 120 deg. to 400 deg. fahr. was by the dynamical method. This new work by Holborn and Baumann is by the statical method. The water was contained in a steel vessel surrounded by a constant temperature bath; absolute measurements of the pressure were obtained by means of a weighted rotating plunger; the volume of water

[1]Annalen der Physik, 1910, vol. 31, pp. 945-970.

in the vessel could be varied either continuously at an approximately uniform rate, or intermittently.

6 In presenting their results, Holborn and Henning used as a standard of reference the following formula of Thiesen:—

$$(t+273)\log\frac{p}{760}=5.409\,(t-100)-0.508\times10^{-8}\left[(365-t)^4-265^4\right]$$

in which the pressure p is in mm. of mercury at 0 deg. cent. and the

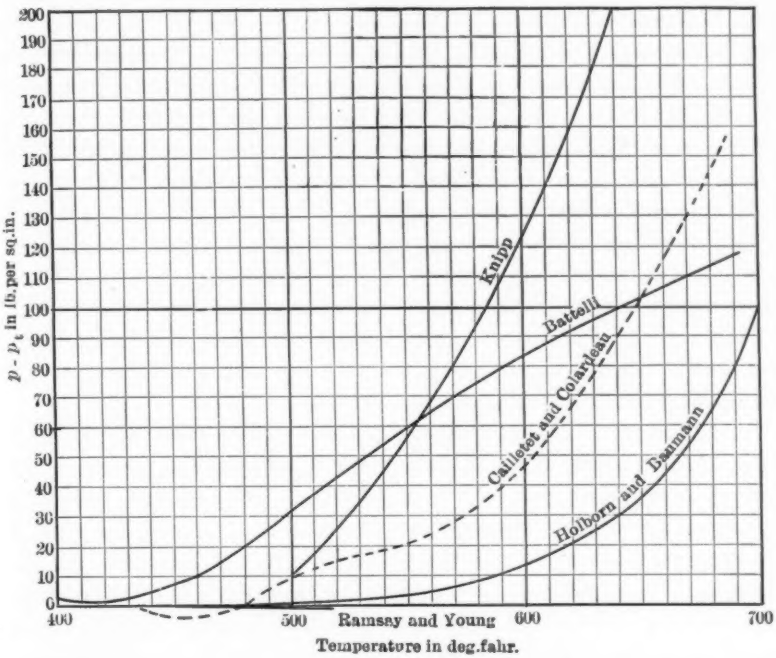


Fig. 1 Curves Showing Deviation of Pressure p Observed by Various Investigators from Pressure p_t Calculated from Modified Thiesen Equation for Temperature above 400 deg. fahr.

temperature t is in deg. cent. The deviation of their experimental values of the temperature from those calculated from the formula is small and is given by a correction curve.[1] The Thiesen formula also fits the Scheel and Heuse results up to 120 deg. fahr. with great exactness. Holborn and Baumann have followed a similar procedure in presenting their results for temperatures above 400 deg. fahr.

[1]Marks and Davis' Steam Tables, p. 94.

The equation they have adopted as a standard of reference is a modification of the Thiesen equation. Their equation is

$$(t+273) \log \frac{p}{1.0333} = 5.3867\ (t-100)-0.5262 \times 10^{-8}\ [(365-t)^4-265^4]$$

where p is in kg. per sq. cm. and t is in deg. cent.

7 This new equation fits the experimental data extremely well from 212 deg. to 400 deg. fahr. The maximum difference between the observed and calculated pressures at any temperature within that range is 2 mm. of mercury or about 0.04 lb. per sq. in. At temperatures in excess of 500 deg. fahr. this equation does not give good results and its error increases very rapidly as the temperature increases beyond that value. The difference between the observed pressures and those calculated from the above equation are shown graphically in Fig. 1. There is also added for comparison the corresponding deviations of the experimental values of Battelli, of Cailletet and Colardeau, of Knipp, and of Ramsay and Young from the same equation. It is obvious at once how great is the discrepancy between these various experimental results, and it is also evident that the results of Cailletet and Colardeau agree much better with the latest work than do the others. The agreement with the results of Ramsay and Young, which extend only to about 520 deg. is good.

8 Holborn and Baumann have presented their results in tabular form. A column in Table 3 gives their results in English units, as deduced from their table by interpolation. It gives the pressures corresponding to each 10 deg. fahr. from 400 deg. fahr. to the critical temperature. As the second differences in the original table do not run smoothly, it will be found that the same is true of the second differences in this table. The values determined by Cailletet and Colardeau are included in the same table for purposes of comparison.

9 There is but little doubt that these new values should be accepted in preference to all earlier values. It is probable that they are not final; the investigators noted, contrary to the observations of earlier investigators, that the water acted on the walls of the steel vessel and that after repeated heatings over 570 deg. fahr. a small quantity of iron went into solution in the water and that the water became colored on standing in the air. There was evidence also that gas was formed in the vessel as a result of this action. It is possible that the same actions have taken place with the earlier investigations in which steel vessels were used, but that they passed unnoticed. Notwithstanding this evidence of the presence of small quantities of impurities in the vessel at the highest temperatures, it seems prob-

able that the results have a high order of accuracy. The probable degree of accuracy is so high that it is doubtful indeed whether any other investigator will be tempted to explore this field for a long time.

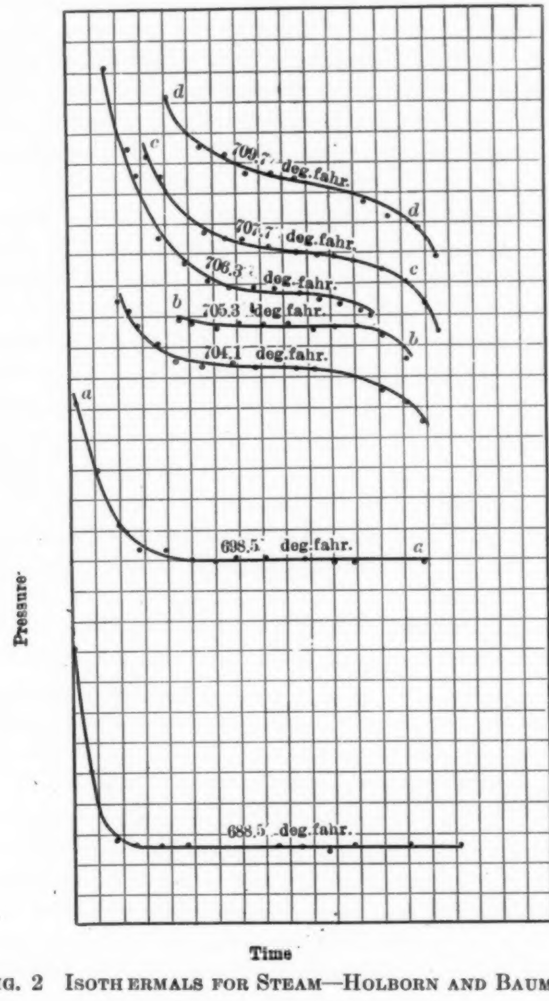


FIG. 2 ISOTHERMALS FOR STEAM—HOLBORN AND BAUMANN

10 It has been previously noted that there was in this investigation the possibility of varying continuously and at an approximately constant rate, the amount of water contained in the steel vessel. If the vessel is initially full of water at a pressure in excess of the

saturation pressure corresponding to the constant temperature at which the vessel is being kept, the gradual outflow of water will result in a fall of pressure until the saturation pressure is reached. Evaporation will then take place and the pressure will remain steady until all the water has escaped. If the pressures are observed and are plotted against time, the observations will give curves such as *aa*, *bb*, Fig. 2. These are isothermal curves and will be true pressure-volume curves if the rate of outflow of the water is kept constant. If the rate of outflow is not constant, as in these investigations, the curves will be altered in shape, but nevertheless have a horizontal part.

11 If the vessel is maintained at a temperature in excess of the critical temperature and the fluid contents of the steel vessel are permitted to flow out at a constant rate, the pressure curve will be such as *cc* or *dd*, and will not have any constant pressure, or horizontal section, since there cannot be any evaporation. The variation of pressure with time was investigated for a number of different isothermals in the vicinity of the critical temperature with the results shown in Fig. 2. They indicate that the critical temperature of water is about 374.6 deg. cent. or 706.3 deg. fahr. and the corresponding pressure 225 kg. per sq. cm. or 3200 lb. per sq. in.

12 The critical constants as determined in this way differ from the earlier values. The more important of these are given in Table 2.

TABLE 2 CRITICAL DATA FOR WATER

Investigator	Date	Critical Temperature, Deg. Fahr.	Critical Pressure, Lb. per Sq. In.
Nadejdine	1885	676.6	....
Battelli	1890	687.7	2859
Cailletet and Colardeau	1891	689	2944
Traube and Teichner	1904	705.2	....
Holborn and Baumann	1910	706.3	3200

13 It will be seen that the critical values have been continuously raised by the later investigators. The practical agreement of the last two determinations of the critical temperature is probably indicative of a fairly correct value. The method of Holborn and Baumann is well adapted to give good results.

14 Accepting the data of Holborn and Henning and of Holborn and Baumann as the best available, and as probably of very considerable

accuracy, it becomes interesting to ascertain whether any formula can be found to represent them accurately. Most of the formulae which have been suggested become quite inaccurate above 400 deg. fahr. Professor Robert H. Smith[1] has suggested the formula

$$p = -0.16 + 0.0075\,t + 2.816 \times 10^{-10}\,t^{4.588}$$

which fits the Cailletet and Colardeau values extremely well up to 600 deg. fahr. with a maximum error of 0.3 lb. per sq. in. at 300 deg. fahr., but with large errors above 600 deg. fahr. The writer has not tried an equation of that general form with the new values; but there is little doubt that a satisfactory equation of that form could be found. It has seemed better, however, to proceed along different lines in looking for the desired equation.

15 The pressure and temperature of a substance can be expressed in terms of any unit. In seeking for a form of statement of the pressure-temperature relations of a saturated vapor, which may possibly apply to the vapors of many, or even of all substances, it is desirable to express the pressures and temperatures *not* as multiples of the usual units (lb. sq. per in. and deg. fahr.), but as fractions of the absolute critical pressure and temperature of the substance under consideration. Taking 3200 lb. per sq. in. and 1106 deg. fahr. as the critical constants for water, a pressure of 1600 lb. per sq. in. becomes 0.5 in the new units, and an absolute temperature of 553 deg. has the same value in the new units. Pressures and temperatures expressed in these units are called reduced pressures and temperatures, and substances at the same reduced pressures and temperatures are said to be in corresponding states.

16 There has been considerable speculation as to the relations between the properties of substances which are in corresponding states. The most obvious hypothesis, suggested by a cursory examination of the saturation data for various substances, is that substances at the same reduced temperatures have the same reduced pressures. For example, water at a reduced temperature of 0.7 (=816.4 deg. abs.) has a pressure of 146 lb. per sq. in. or a reduced pressure of 0.0456. Ammonia (critical temperature 730 deg. abs., pressure 1690 lb. per sq. in.) at a reduced temperature of 0.7 (511 deg. abs.) should have according to this hypothesis, the same reduced pressure (0.0456) or a pressure of 77.1 lb. per sq. in. The observed pressure is, however, 90.7 lb. per sq. in. The hypothesis will be found to give only a very

[1]The Engineer (London), August 26, 1910.

rough approximation to the observed facts in many cases. If the hypothesis were true we should have the equation

$$\frac{p}{p_c} = f\left(\frac{T}{T_c}\right)$$

where p_c and T_c are the critical constants and p is the absolute saturation pressure corresponding to any absolute temperature T.

17 Van der Waals[1] assumes the equation given in Par. 16 to have the special form

$$\log \frac{P_c}{p} = a\left(\frac{T_c}{T} - 1\right)$$

where a is a constant with the same value for all substances, with an approximate value of 3. This equation gives results which are near enough to the facts to suggest that it has some logical basis, but which gives errors too great for practical use. It has the positive merit of being accurate at the critical temperature, but it is found that the value of the constant a differs with the substance. Nernst[2] gives the following values of a which, he says, hold for the range $\frac{T_c}{T} = 1.5$ to 2.0, a range which is the important range for water.

Hydrogen	1.83
Argon	2.17
Nitrogen	2.45
Oxygen	2.53
Carbon bi-sulphide	2.63
Chloroform	3.00
Ether	3.15
Propylacetate	3.39
Ethyl alcohol	4.05

He gives also a series of curves, Fig. 3, which seem to show a straight line relation between log $\frac{p_c}{p}$ and $\left(\frac{T_c}{T} - 1\right)$.

18 If the van der Waals equation were true for all these substances, the lines would all be straight lines; and if a were constant they would be superposed. Applying the equation to saturated steam and finding the values of a corresponding to different reduced temperatures, it becomes evident at once that a is not a constant, but

[1]Continuität der gasförmigen und flüssigen Zustandes, p. 147.
[2]Gottingische Nachrichten, Math.-Phys. Klasse 1906.

varies as in the curve, Fig. 4. This curve goes through a minimum for a value of $\frac{T}{T_c}$ approximately of 0.78. The curve suggests that a varies with $\frac{T_c}{T}$ according to the equation

$$a = b\left[1 + c\frac{T}{T_c} + d\left(\frac{T}{T_c} - 0.78\right)^2\right]$$

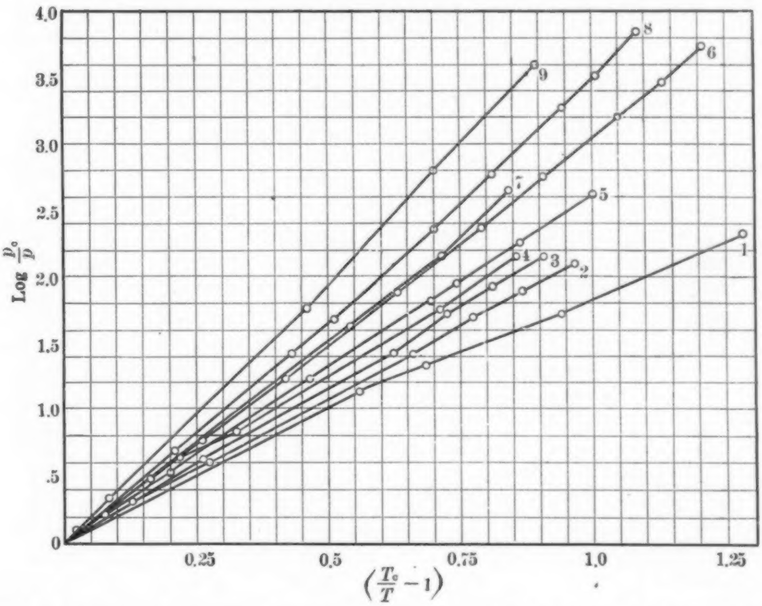


FIG. 3 CURVES SHOWING APPLICABILITY OF VAN DER WAALS EQUATION TO (1) HYDROGEN, (2) ARGON, (3) KRYPTON, (4) OXYGEN, (5) CARBON BI-SULPHIDE, (6) FLUORBENZOL, (7) ETHER, (8) PROPYLACETATE, (9) ETHYL ALCOHOL, TAKEN FROM NERNST

where b, c and d are constants. By a few trials it was found that 0.7875 gave somewhat better results than the approximate value of 0.78 in the last term. The van der Waals equation as modified for the variation of a becomes

$$\log\frac{p_c}{p} = b\left[1 + c\frac{T}{T_c} + d\left(\frac{T}{T_c} - 0.7875\right)^2\right]\left(\frac{T_c}{T} - 1\right)$$

19 This equation is very sensitive to slight variations in the assumed values of the critical constants. Assuming the critical pres-

sure to be 3200 lb. per sq. in., the corresponding critical temperature which was found to give calculated results in closest accord with the experimental results was 706.1 deg. fahr. A variation of $\frac{1}{10}$ deg.

TABLE 3 EXPERIMENTAL AND CALCULATED PRESSURES OF SATURATED STEAM FROM 400 DEG. FAHR. TO THE CRITICAL TEMPERATURE

Temperatures, Deg. Fahr.	Pressures, Lb. per Sq. In.			Deviation of Formula From Holborn and Baumann	
	Cailletet and Colardeau	Holborn and Baumann	By Formula	Lb. per Sq. In.	Percentage
400	247.1	246.99	247.10	+0.11	0.044
410	276.4	276.34	276.47	+0.13	0.047
420	308.4	308.33	308.47	+0.14	0.045
430	343.2	343.18	343.26	+0.08	0.023
440	380.8	380.92	381.02	+0.10	0.026
450	421	421.85	421.87	+0.02	0.0047
460	465	465.95	466.04	+0.09	0.019
470	573	513.65	513.66	+0.01	0.0019
480	565	565.08	564.93	−0.15	−0.026
490	622	620.18	620.05	−0.13	−0.021
500	684	679.26	679.18	−0.08	−0.012
510	751	742.55	742.56	+0.01	0.0013
520	822	810.31	810.37	+0.06	0.0074
530	897	882.58	882.82	+0.24	0.027
540	977	959.85	960.15	+0.30	0.031
540	1062	1042.2	1042.6	+0.4	0.038
560	1152	1130.2	1130.3	+0.1	0.0089
570	1247	1223.7	1223.7	0	0
580	1349	1323.0	1322.9	−0.1	−0.0076
590	1458	1428.3	1428.1	−0.2	−0.14
600	1574	1539.9	1539.8	−0.1	−0.0065
610	1697	1657.8	1658.1	+0.3	0.018
620	1827	1782.9	1783.3	+0.4	0.022
630	1965	1915.3	1915.9	+0.6	0.031
640	2111	2055.1	2056.0	+0.9	0.044
650	2265	2203.1	2204.2	+1.1	0.049
660	2428	2359.2	2360.5	+1.3	0.055
670	2599	2523.4	2525.6	+2.2	0.067
680		2697.1	2699.7	+2.6	0.096
690		2882.3	2883.3	+1.0	0.035
700		3080.4	3076.8	−3.6	−0.117
706.1		3200.0	3200.0	0	0

fahr. in the assumed critical temperature has a very marked effect on the calculated pressures at the highest temperatures. The value of the critical temperature given by Holborn and Baumann is 706.3

deg. fahr., but it is certain that their method cannot give results which are reliable to within a few tenths of a degree. It is probable that an equation which fits the experimental facts for a range of over 600 deg. fahr. may be extrapolated with some certainty for 20 deg. or 30 deg. In obtaining the constants in the equation it was consequently assumed that the critical temperature was 706.1 deg. fahr. or

$$T = 706.1 \text{ deg.} + 459.64 \text{ deg. fahr.}$$

After numerous trials the following equation was finally adopted

$$\log \frac{p_c}{p} = 3.006854 \left(\frac{T_c}{T} - 1 \right) \left[1 + 0.0505476 \frac{T}{T_c} + 0.629547 \left(\frac{T}{T_c} - 0.7875 \right)^2 \right]$$

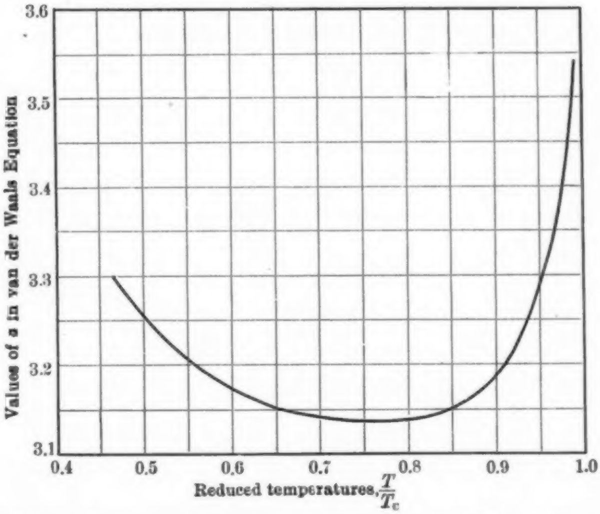


Fig. 4 Curve Showing Variation of a in van der Waals Equation for Saturated Steam

Inserting the chosen values of the critical constants this reduces to

$$\log p = 10.515354 - 4873.71\, T^{-1} - 0.00405096\, T + 0.000001392964\, T^2$$

20 The agreement of the pressures calculated from this equation with the experimental results of Holborn and Baumann is very striking and is shown in Table 3, which gives the calculated pressures and the differences from the experimental results, expressed both in lb.

per sq. in. and in percentages. It will be seen that from 400 deg. to 650 deg. the difference is nowhere so great as $\frac{1}{20}$ of 1 per cent. From

TABLE 4 EXPERIMENTAL AND CALCULATED PRESSURES OF SATURATED STEAM FROM 32 DEG. TO 400 DEG. FAHR.

Temperatures, Deg. Fahr.	Pressure, Lb. per Sq. In.		Deviations of Formula From Tabulated Values	
	Marks and Davis' Steam Tables	By Formula	Lb. per Sq. In.	Percentage
32	0.0886	0.088563	−0.000037	−0.042
50	0.1780	0.17765	−0.00035	−0.196
100	0.946	0.946	0	0
150	3.714	3.707	−0.007	−0.188
200	11.52	11.504	−0.016	−0.139
250	29.82	29.802	−0.018	−0.060
300	67.00	67.00	0	0
350	134.6	134.60	0	0
400	247.1	247.10	0	0

650 deg. to the critical temperature the maximum difference is slightly greater than $\frac{1}{10}$ of 1 per cent but becomes zero at the critical

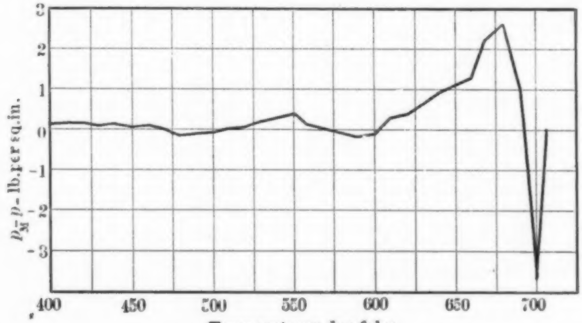


FIG. 5 CURVE SHOWING DIFFERENCE BETWEEN CALCULATED PRESSURE p_m AND OBSERVED PRESSURE p_1 FOR TEMPERATURE RANGE FROM 400 DEG. FAHR. TO THE CRITICAL TEMPERATURE

temperature. The curve, Fig. 5. shows the difference in lb. per sq. in. It is probable that but little weight should be given to the differences in the neighborhood of the critical temperature in view of the decreasing accuracy of the experimental results in that vicinity.

21 Below 400 deg. fahr. the agreement of the equation with the experimental results is shown in Table 4. The experimental results are those of Holborn and Henning from 120 deg. to 400 deg., and of Regnault and other investigators below 120 deg. The differences are very small as expressed in lb. per sq. in., but amount nearly to $\frac{1}{5}$ of 1 per cent in some cases. These differences are not greater than the variations among the best experimental values in this part of the temperature range. For example, the new and excellent work of Scheel and Heuse gives a pressure of 0.088444 lb. at 32 deg. fahr. as against 0.0886 lb. given in Table 4 (from Regnault's work) and 0.088563 lb. calculated from the equation. The equation value is almost exactly the mean of the two experimental values.

22 The equation given in Par. 19 has, it is believed, the advantage over previous equations of greater simplicity, greater accuracy, and also of the great ease in finding $\frac{dp}{dt}$ for use in the Clapeyron equation.

23 I am indebted to H. J. Macintire, Jun.Am.Soc.M.E., for most of the numerical work in obtaining the equations.

FIRES: EFFECTS ON BUILDING MATERIALS AND PERMANENT ELIMINATION[1]

By Frank B. Gilbreth, Published in The Journal for May, 1910

ABSTRACT OF PAPER

The author calls attention to the enormous annual fire loss amounting to over $456,000,000, during 1907, in addition to which 1449 persons were killed and 5654 were injured in fires. If buildings in this country were as nearly fireproof as in Europe the fire loss would be $90,000,000 and the United States is therefore paying a preventable tax of over $366,000,000. As a result of painstaking observation at a number of the great fires, the author believes that no structure of the future should be built of wood or contain any wood, and he states that the increasing cost of lumber and the improved methods of fireproof construction have made it possible to build non-combustible structures at no greater cost than wooden ones. The disuse of wood in building construction would mean the saving of forests, uninterrupted business, the saving of life, the saving of buildings and the saving of the contents of buildings. The author believes that the permanent elimination of fires can never be thoroughly and completely brought about without Governmentaid and suggests the following lines along which Government assistance can be directed: *a*, by passing laws restricting the use of wood in buildings; *b*, by levying taxes discriminating in favor of fireproof houses and against wood in construction; *c*, by educating the people by Government documents on how to build fireproof houses.

DISCUSSION AT NEW YORK[1]

J. P. H. Perry.[2] A fire in the Dayton Motor Car Company works, at Dayton, O., about eighteen months ago started on the fourth floor of the new reinforced-concrete factory and from there spread into the first-class brick and mill-construction building adjoining. The concrete building was so new that although the sprinkler system had been

[1] This paper was presented in New York, October 11, 1910, and in St. Louis, October 15, 1910, at a meeting of the Society with the Engineers' Club of St. Louis coöperating. The discussion at both meetings has been combined.
[2] Manager Contract Dept., Turner Construction Co., New York.

The American Society of Mechanical Engineers, 29 West 39th Street, New York. All discussion is subject to revision.

installed, it had not yet been connected; neither had the automatic fire doors, protecting the openings from the new into the old building, been put in place. The fire entirely gutted the fourth floor of the concrete building and destroyed the roof, fourth and third floors of the brick building, cracking the walls and practically ruining the building. Despite the severity of the fire in the concrete building, it was only two days after the fire before the owners began to install new machinery on the burned-out floor, Little or no repairs were necessary.

One of the buildings which survived the Baltimore fire had a structural frame of reinforced-concrete columns, beams, etc., but the walls were of brick. These last collapsed, although the concrete portion remained in place, surviving the fire without serious damage.

Fire tests of concrete structures, similar to these two, occurred in the glue factory of F. W. Tunnell Company, near Philadelphia, and the Thompson and Norris Buildings, Brooklyn. In both cases the test was a severe one and yet concrete demonstrated indisputably its value as a fire-resistant material.

Not infrequently one hears statements to the effect that concrete construction is slow and in several instances to my knowledge structural steel or mill construction has been adopted because of the imagined length of time reinforced concrete would take. As a matter of fact, for rebuilding after fires concrete compares well with any other type of building. Work can be started on the foundations as soon as the débris of the building destroyed by fire has been removed, and without waiting for complete plans to be prepared, steel to be detailed, rolled and fabricated at the mills, as is the case of structural steel. I do not intend to convey the impression that a concrete frame work will go up as fast as structural steel, but the time of completion compares well with other types.

It is frequently said that it is difficult to make changes in concrete buildings, such as installing sprinkler or plumbing pipes, or running shafting, or setting motors in place, where they had not originally been intended. In Figs. 16 and 17 are given a few typical details showing how this problem has been most satisfactorily solved in a great number of concrete buildings already erected in this territory. The best answer to complaint by the uninformed on this property of concrete is reference to the great Bush Terminal buildings in Brooklyn. These buildings will aggregate, when those in construction at the present time are completed, some 79 acres of floor space, all of which is for rental purposes. The owners in selecting reinforced con-

crete for these buildings had to meet the requirements of unknown tenants of many different kinds. Not only did the structural material selected have to be as fireproof as possible, but it also had to adapt

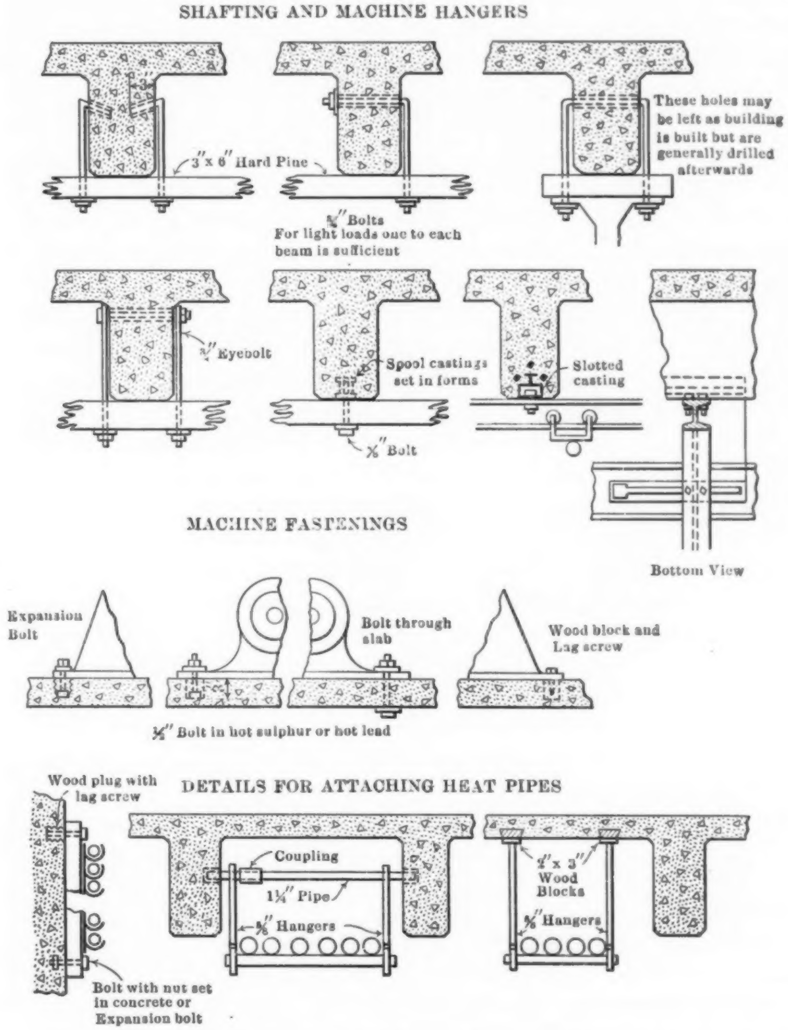


Fig. 16 Details of Hangers and Fastenings in Concrete Buildings

itself readily to the needs of occupancy conditions probably of one hundred different classes of manufacturing and storage companies.

The continued construction of new buildings for this concern and the ease with which they are rented should furnish a most positive answer as to the satisfaction of reinforced concrete for industrial purposes.

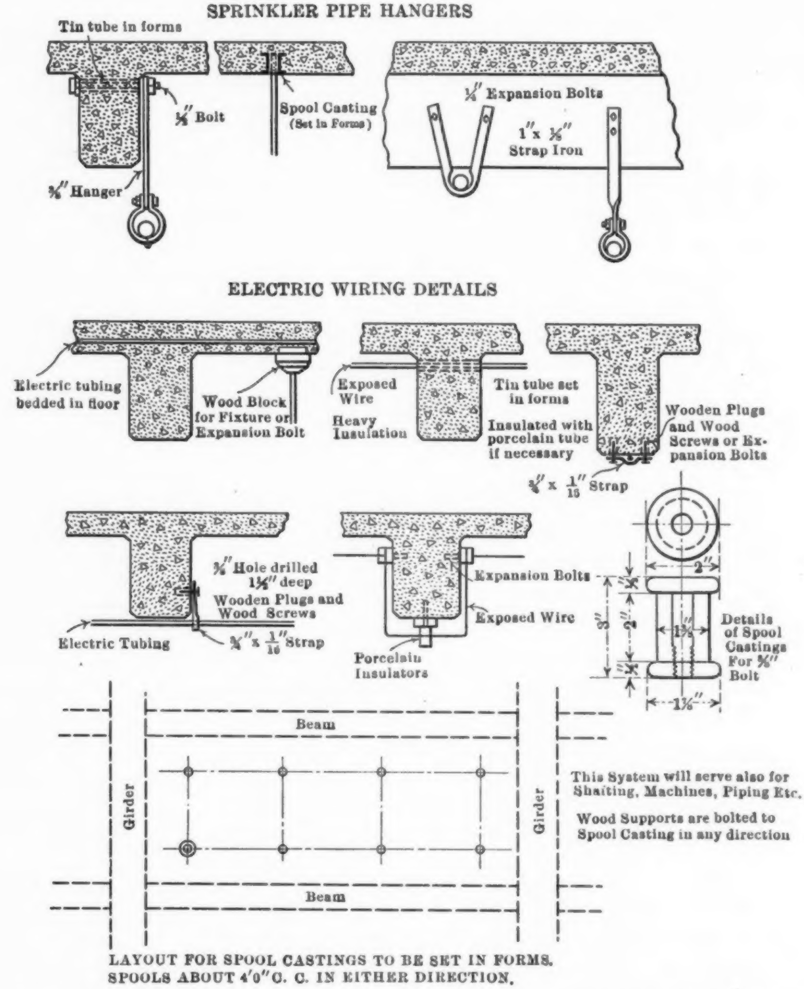


Fig. 17 Methods of Installing Sprinkler Pipes, Electric Wiring and Machinery in Concrete Buildings

I have just received reports of some tests of the waterproof character of concrete floors. In most fires the damage is quite largely that occasioned by water, and the tightness of concrete floors is very impor-

tant. In the first four factories constructed for the Bush Terminal Company, wooden floors laid on sleepers were specified. In factories Nos. 5, 6 and 19 the owners have omitted the wooden floors and have substituted granolithic floor finish. This floor finish was not laid monolithic with the floor slab, as is customary, but instead, the granolithic finish, 1 in. in thickness, was laid on 2 in. of rich cinder concrete over the supporting slab. This change was made in spite of the imaginary objections of employees against concrete floors. An even more important factor in bringing about this change was the waterproof property of such construction. In one of the factories having wooden floors laid on wooden sleepers placed in cinder fill on the supporting stone concrete slab, there occurred recently a small fire. The water leaked through into the story below, coming through inevitable shrinkage cracks. The National Board of Fire Underwriters then took the stand that they would not quote minimum rates on these buildings unless waterproofing was laid under the floor sleepers so as to avoid possible water damage. To avoid this expense of waterproofing the character of floor finish above described was adopted. It had proved successful as a permanent finish on winter weather jobs, and it seemed worthy of consideration as being watertight.

Warehouse "A" of the Bush Terminal Company, which has this type of granolithic floor finish throughout, is a six-story and basement structure, 150 ft. sq. One entire floor, 22,500 sq. ft., was flooded with water. The floors pitch from the center to the wall scuppers about 6 in. These scuppers and the elevator and stair well openings were closed. Water to a depth of about 5 in. at the outside walls remained on the floor four days. The amount of water which leaked through the floor was very small and no water appeared on the ceiling below until the water had been on the floor for about five hours. This test was viewed by the underwriters and was pronounced extremely satisfactory. I understand that this type of floor construction has been approved as being waterproof.

H. DE B. PARSONS. The old adage, "an ounce of prevention is worth a pound of cure," contains much that is worth practicing. The ratio in the phrase is 1 in 16, but with fire risks it would seem truer to place the ratio at 1 in 100 and alter the phrase to suit, "a cent of prevention is worth a dollar of cure." Even that proportion of the cost of a building is rarely properly spent to reduce the fire hazard. Many owners of buildings spend large sums in fire apparatus, extinguishers and the like but the same amount of money

and energy spent on original construction and design would have been more effective.

The value of a building depends on its income-earning capacity and it is a well established fact that safe buildings command little, if any, additional rent over those in which such qualities are but veneer. Tenants are guided chiefly by modern conveniences and showy appearances. Many imagine because iron and steel are incombustible

FIG. 18 DAMAGE BY FIRE TO HOME LIFE INSURANCE COMPANY'S BUILDING, NEW YORK CITY

that buildings constructed of such materials, together with glass, bricks and cement, can always be classified as fireproof. Such buildings may be proof against an internal fire when empty, but unfortu-

nately, full consideration is not always given to the effect of inflammable contents or of the hazard caused by a neighboring structure.

The design of a real fireproof building is more difficult of execution than is generally imagined. The term fireproof has become generic and is, in many instances, a misnomer. In its broad sense it is used to classify a certain style of modern construction that has become very popular, as is attested by the wonderful and rapid increase of such buildings in our cities.

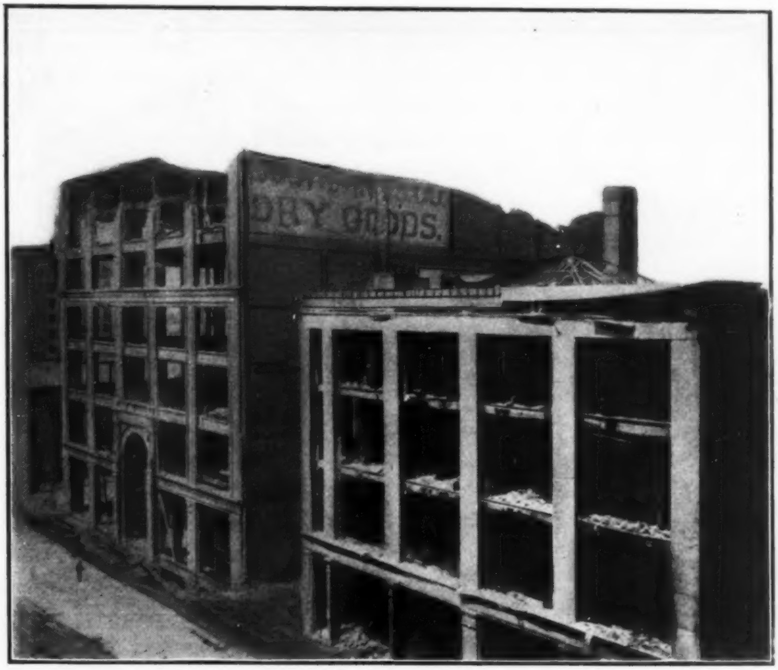


Fig. 19 The Horne Dry Goods Store and the Horne Office Building, Pittsburg, Showing Injury by Fire Originating in Other Buildings

It is impossible to conceive of a building that cannot be damaged by fire. The more fireproof a building is made the greater will be its cost and the less its utility for modern demands. The problem is economic and must be settled by balancing the questions involved.

A fireproof structure may then be defined as one that will be damaged by fire to a minimum extent, while considering the hazards from within as well as from without; one in which the injury will be localized; and one in which the main supporting or weight-carrying members will not be injured to an extent that will render them useless.

In 1896 The American Society of Mechanical Engineers entered into a joint committee with architectural and insurance interests for the purpose of making tests on structural material. The chief work of this committee is described in the Transactions of 1907. When unprotected steel or cast-iron columns were exposed to the direct action of heat and the heat was applied rapidly, the columns failed in less than 30 minutes from the application of the heat, or when they began to show red in the light of the flame.

FIG. 20 SO-CALLED FIREPROOF BUILDINGS BADLY INJURED BY FIRE FROM ADJOINING STRUCTURES

This same result was shown in the destruction by fire of a mill or steel and brick construction in Worcester, Mass. The steel work of this mill was unprotected and the columns gave way between 15 and 25 minutes after the fire started.

Tall buildings as now constructed in our large cities act well as fire-stops. With the best construction they probably afford a very fair degree of protection to the occupants, but they are all vulnerable to the attack of fire from without, that is, to the external hazard. This latter condition was well exemplified in the fires which occurred

in the Manhattan Savings Bank Building and in the Home Life Insurance Company's Building, in New York City (Fig. 18); in the Horne Dry Goods Store and the Horne Office Buildings in Pittsburgh (Fig. 19), and in the new tall buildings of so-called fireproof construction in the city of Baltimore (Fig. 20). All of these buildings were badly injured by fires originating in other structures.

A tall building is vulnerable to a fire without because the fire can enter through the windows on the different floors at the same time. When this condition happens it practically places the building beyond the help of the fire department until considerable destruction has been affected.

Tall buildings are also vulnerable to fire through floor openings and wells for elevators, stairways, etc. These openings from basement to roof form a flue through which the fire is rapidly drawn to every floor. The practice of cutting transom lights in the partition walls dividing the various departments is also a great fire hazard and permits a fire originating on one apartment to spread to the adjoining rooms. Many so-called fireproof tall buildings contain a very large percentage of weight in wooden construction. By careful planning much of this wood can be omitted or really non-combustible material substituted for it.

The question naturally arises whether or not it pays the owner to make a building fireproof. Unfortunately there are many who build for the specific object of obtaining the greatest income from a minimum outlay, and the effort to save on first cost is so great as to render their judgment valueless as to what should or should not de done. Tall buildings of cheap construction are a menace not only to owners and tenants but to the community.

Nearly every builder estimates the amount of space devoted to public use, and concludes that the best building is the one that has given up the least percentage. While this effort is commendable from a purely income-earning standpoint, it often renders the design dangerous to life and property, and frequently makes it impossible to design a building under conditions which can be classed as fireproof. As long as stairways and elevators are placed together in the same well there must always be a strong tendency to cut off escape as well as a menace of saving property from the floors above the place where the fire originates.

Owners do not hesitate to spend thousands of dollars on fancy marble panelling, architectural carving and similar ornamentation, and will refuse to spend a few hundred dollars to have plans prepared

properly and to see that the dangerous parts are constructed with that care which a really fireproof building should demand.

Ira H. Woolson. I agree most heartily with Mr. Gilbreth's appeal for a really fireproof construction, though I am not prepared to endorse the refinements of concrete house molding which he advocates. I question also the feasibility of his scheme for a central manufacturing plant from which certified concrete is to be distributed about a town. That scheme might work where a whole new town were to to be built at one time, but for efficiency and economy it would be necessary that a plant of that character be in continuous operation, and I can not see how that could be accomplished with the ordinary irregular building activity of a city.

There is no material which compares for an instant with wood for utility, economy, and artistic effect for interior trim, but there is none so dangerous. Admitting these conditions, it is evident that everything should be done, that can be done consistently, to make our homes more safe. It is not necessary, however, that such houses be cast of concrete in order to make them fire-resisting, Many beautiful and comparatively cheap houses have been constructed of terra cotta tile, concrete tile and concrete building blocks. Such houses can be rendered strictly fireproof by combining incombustible trim with metal doors and window sashes, and if desired, a reasonable amount of wooden trim, treated to make it non-flammable, could be employed without serious danger.

Unfortunately we are more extravagant than any other people in our use of wood in building construction. The practice is a most pernicious one and, as pointed out in Mr. Gilbreth's paper, we are paying a tremendous price for our folly. But the gravity of the situation is being realized more and more, and statistics of fire losses gathered by the Government and underwriting organizations are being studied by thoughtful men throughout the land. Valuable papers are being published suggesting methods of stopping this terrific loss. It can not be stopped, however, until the public is made to understand the magnitude of the waste, and taught how it can be avoided. When the gravity of this danger from fire is fully understood and the fact that it can with certainty be very largely prevented by proper precautions, the reformation will be half accomplished. The demand for strictly fireproof buildings will become so insistent that other types of buildings will be unpopular and unprofitable.

Mr. Gilbreth discusses at some length the construction of a fireproof dwelling, but it is not clear to what type of dwelling he refers.

He seems to imply the ordinary two or three-story structure commonly known as a private house. A building of that kind can undoubtedly be made fireproof, but if designed to be artistic and handsome, it will necessarily be more expensive than if built of non-fireproof construction. As a general proposition, it is difficult to make a handsome house strictly fireproof and have it satisfy the artistic taste of the archirect and owner. However, that type of dwelling is a very small minority in New York City, and aside from its limited number, I consider it the type that is least important to be made fireproof.

The restrictions of our building laws have so operated as to give us in this city three general types of dwellings: the private house, 2 to 4 stories high; the 4 to 6-story flat or apartment (usually non-fireproof); and the 10 to 12-story so-called fireproof apartments or apartment hotels.

In the manner of construction there is but little difference between the first two types. They have both either stone or brick walls, wooden joists, wooden partition studding, wooden lath, and any quantity of wooden trim. There is little attempt to make them fire-resisting, though the tenement house over four stories high must have the first floor made fireproof to hold back basement fires, and the hallways and stairs are to a certain extent fire-resisting.

The private house is usually better built, because constructed with less economy, but only the expensive ones are in any degree fireproof. However, the private house usually harbors but one family. They have large rooms, generous stairways, and only three or four floors. If a fire occurs, human life is seldom sacrificed. Hence my assertion that the fireproofing of this class of dwelling is the least important.

Looking at one of these tenement buildings in the course of erection, one is reminded of a tangled mass of tooth picks. From ground floor to roof there is a forest of 2 in. by 4 in. studding, supported by tiers of yellow pine or spruce floor beams, all of which are later boxed in by $\frac{7}{8}$-in. flooring, and plaster on wooden lath. The result is a 5 or 6-story brick box divided into a host of little rooms, closets, narrow halls and stairways. These little box-like rooms are filled to overflowing with tenants, and the whole structure is a fire-trap and a disgrace to the city. There are miles of such constructions, constituting a constant menace to our city's safety. Fires in them are of daily occurrence and loss of life is frequent. As a matter of fact, the loss of life at these fires is so common that the record in the daily papers scarcely causes comment. In the past 20 days there have been 40 good sized fires in 5 and 6-story tenements in the boroughs of Man-

hattan, Bronx and Brooklyn, and scores of small ones. Though no lives have actually been reported lost in that period, there have been a score of thrilling rescues and several persons were injured and burned.

Many of the tenements are filled with an ignorant, vicious class of foreign population, and numerous fires result from their carelessness. Among this class, also, a favorite revenge for fancied wrongs is to start a fire. A cup of kerosene or a few oily rags are all that is necessary to produce a lively blaze and instantly a hundred or more innocent people are in deadly peril. But this type of construction is by no means confined to the tenement districts. The cross streets and broad avenues of the best portions of our city are lined with them, and they are a constant source of worry to the fire department. If the two or three conditions which are necessary to start a conflagration ever occur simultaneously, we will have a fire horror in this city which would discount the records of Boston, Chicago, Baltimore and San Francisco. It is the worst of foolishness to continue such construction in a congested city like this. Must we have an awful lesson here before the practice is stopped?

The third class of dwellings is the 12-story apartment. The building laws of New York City permit one to build pretty nearly as one pleases as regards fireproofing, up to 6 stories; from 6 to 12 stories he must make the floors, partitions, elevator shafts and stairways fireproof, but he may still use unlimited wood for trim. Above 12 stories, if wooden trim is used it must be treated to make it non-flammable, otherwise metal trim, or wood covered with metal must be substituted. This last type of building is really very safe if honestly built. It is distinctly the office building type, the so-called skyscraper, but it also includes some of our large apartment houses and apartment hotels.

Buildings of this class are safe as regards destruction from an ordinary fire. At least they will hold the fire until firemen can prepare to combat it. They may justly be called fireproof. As a class they are being very satisfactorily built at the present time. In buildings of the 12-story type, if properly constructed, a fire ought to be confined to the apartment in which it started, so far as interior transmission is concerned. The great danger, however, is that the fire will travel from floor to floor by exterior transportation, that is, by way of the windows.

This is a serious menace to both life and property. Of course, very much greater security could be obtained by the use of wired glass windows, in metal sashes. It takes very little heat to break an ordinary

plate-glass window pane, but wired glass in a metal frame will remain in place until it melts. There is objection to the use of wired glass in windows which are to be used for observation purposes, but I believe much protection could be obtained from the window exposure hazard, if the upper sash were required to be wired glass. This would not obstruct the view, nor injure the artistic effect of the room, but it would serve to confine the flames in the top of the room and when they did get out they would issue through the lower sash, some three or more feet below the top of the window. This increase of distance

FIG. 21 ONE OF THE DINING ROOMS AFTER THE FIRE
As the floor was unoccupied, the only thing to burn in this "fireproof" (?) room was the trim.

between the windows of the two floors, would materially lessen the danger of communicating a fire to a floor above.

The quantity of lumber used for trim and decoration in the 12-story so-called fireproof apartments is astonishsing. Figs. 21 to 24 illustrate the perniciousness of this practice. They were taken after a fire a few months ago in an extremely handsome apartment house in the upper part of New York City. There were literally wagon loads of

highly inflammable wooden trim used in each apartment, and this produced a terrific blaze, which shot out of the windows and into the windows of the floor above, where the same thing was repeated. Four apartments vertically over each other were thus burned out by the flames jumping from window to window. Although there were apartments on each side of these which burned, no transmission of fire occurred on the interior. Had the trim in this building been non-

Fig. 22 View of Another Dining Room
Note the trim still unburned.

flammable, as it most certainly should be in a building of such pretensions, it is very probable the fire could not have escaped beyond the apartment in which it started.

As an evidence of the ridiculous laxity of our existing building laws as regards the freedom with which a literal bonfire structure may be erected in this city, Figs. 25 and 26 are reproduced from photo-

graphs taken of a building now in course of erection upon one of our most exclusive avenues and on one of the busiest corners in the city. This structure is possible because it is only 75 ft. high. It is colossal folly to permit such construction upon one of the most prominent sites in the city, surrounded by handsome buildings of the older non-fireproof type and many others more modern, which cost millions of dollars.

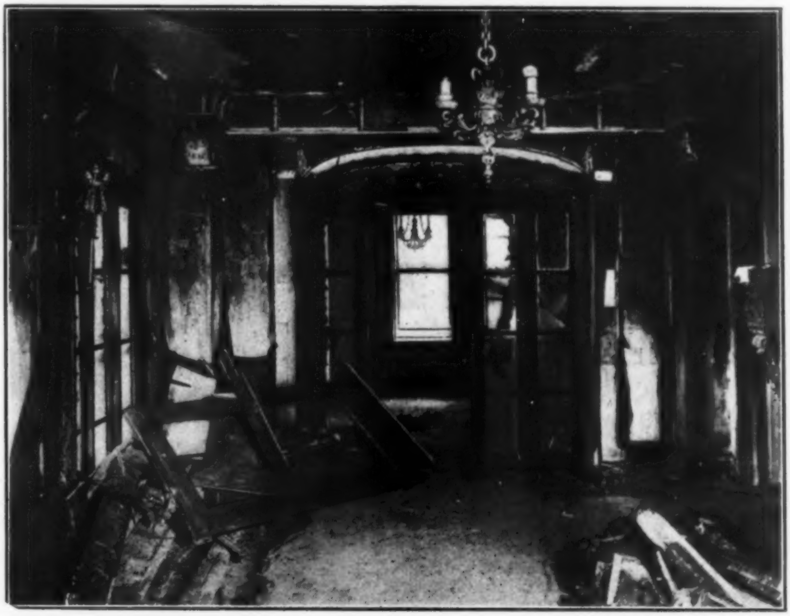


Fig. 23 Reception Hall Just Off the Dining Room
Note the light wooden doors glazed with thin glass and the amount of wooden trim.

The extravagant use of wooden trim shown in Fig. 27 is by no means an isolated instance. The majority of our apartment houses under 13 stories in height are liberally trimmed with wood, though not often to the excess of the one just described. I took occasion recently to have an experienced estimator from a lumber yard go to an apartment up town and carefully measure the wood used in finishing the sitting room and dining room. The building is new and called fireproof, but we were astonished to learn that those two rooms contained the equivalent of over 1700 sq. ft. of soft, highly inflammable wood. Much of it was white wood well covered with paint which would add

to its natural combustibility. This estimate included the door and window bucks, the double flooring and the sleepers which were set in the concrete floor beneath. From this as a basis it was estimated that the whole apartment contained about 4000 ft. and the entire 10-

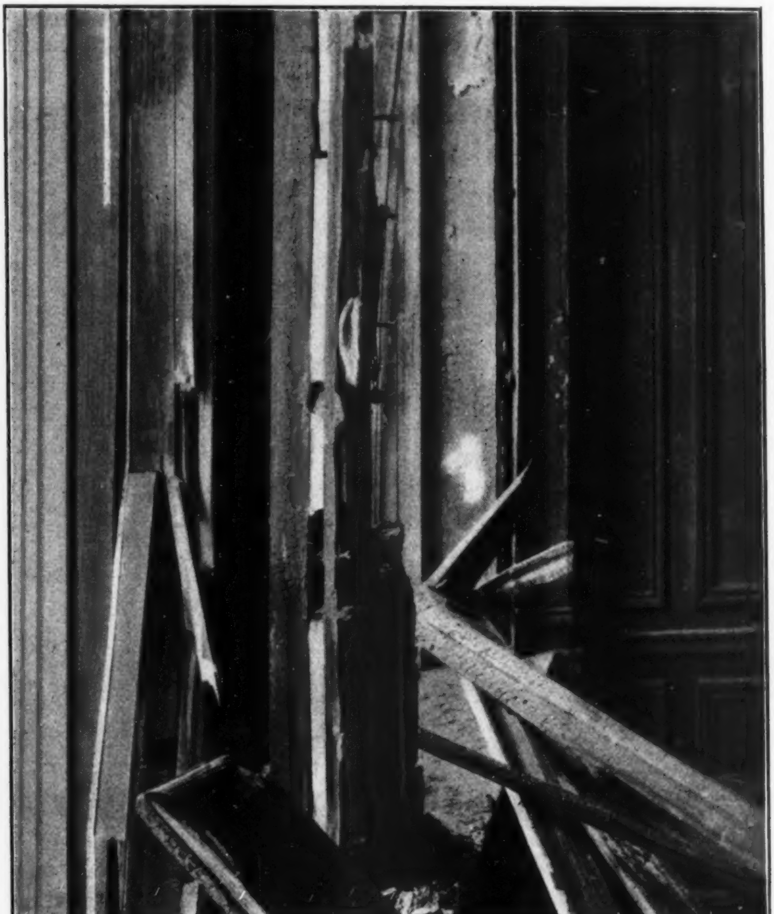


FIG. 24 WOODEN STUDDING AND TRIM USED AROUND WINDOWS
Note concealed air spaces which are known to be very dangerous in case of fire.

story building would total 160,000 ft. equivalent to eight carloads of kiln-dried, painted and varnished kindling wood. Add to this the

furniture and furnishings of each room, and you have the material for a big blaze. Would it be surprising if such a fireproof building were to be completely ruined by a fire? There would be instead cause for astonishment if any considerable portion of it escaped.

This building is no exception in its class. There are hundreds of others like it, and while the fireproof partitions and hallways will usually prevent a fire spreading laterally, there is always grave danger

FIG. 25 BUILDING AT FIFTH AVE. AND 42D ST.
This building is filled with wooden construction.

of its traveling upward by way of the windows, dumb-waiter and air shafts. This type of building would offer very little resistance to a conflagration. Blasts of hot air from nearby burning buildings would ignite the window frames and break the glass on a whole front at once. Under such conditions its complete destruction would be certain. Whether the occupancy were domestic or commercial in character, the buildings would burn with equal fierceness.

FIG. 26 VIEW OF SAME BUILDING LOOKING THROUGH FROM 42D ST. TO FIFTH AVE. ON THE GROUND FLOOR

The 2 in. by 4 in. wooden studding is so thick that all the light is cut off except a few spots.

The dwellers in these 10 and 12-story structures must be taught the danger which surrounds them. They must understand that they are not exempt from fire hazard because they are housed in a building with fireproof floors and partitions and protected hallways. Fill it full of combustible trim and furniture and you have a great stove with air shafts, elevator shafts, and dumbwaiter shafts for flues, and windows acting for either draft openings or flues, depending upon circumstances. These are excellent conditions for a vigorous fire. There is strong probability that a fire well started on the sixth or

Fig. 27 Dining Room on Floor Below where Fire Occurred

seventh floor of such a building would go to the roof and sweep all before it.

The efficiency of the fire department is greatly lessened at that height. Streams of water thrown from the street have little effect, and even a water tower is of doubtful utility above the ninth floor. Firemen must make their fight from the interior of the building, or from fire escapes, with water supplied by a standpipe in the building. If it should fail the situation would be well-nigh hopeless.

The custom of building such structures for dwellings and commercial purposes should cease. It is not in harmony with our boasted civilization and much-vaunted scientific progress. Take a fire like that which recently occurred in a lumber yard on West 24th Street and ruined half a block before it was checked. It needs a very slight tension on ones imagination to picture what would have happened had that fire occurred during a high western wind. Under such conditions it might very easily have escaped from the control of the fire department and plowed its way across the city, a roaring mass of devastating horror. In front of it were miles of buildings similar in character to those described, and they would have gone down before it the same as similar buildings vanished before the conflagrations in Baltimore, Toronto, San Francisco and elsewhere.

Think what such a conflagration would mean in a city like New York, with its enormously congested population and financial values. The result would be appalling. If such a conflagration were to sweep some sections of our city the money losses would be staggering. The credit of the city might be ruined, and the financial system of the country shaken. This is no extravagant vision of an alarmist. It is a real potential possibility, and it is high time we began to limit this hazard by insisting that all high buildings be fireproof in fact as well as in name, and that all buildings over two stories high shall have fireproof floors, partitions and hallways.

I fear this will never be accomplished by appealing to the public spirit of the speculative builder. He is building to sell, and the cheapest, flimsiest construction that the law will allow is the one he will adopt. Building laws must be enacted which will prohibit the erection of inflammable structures within our congested areas, and then we must insist upon a strict enforcement of the same. Such laws will not be enacted until citizens appreciate their necessity and demand that their representatives decree them.

P. H. Bevier.[1] The writer would like to discuss this able paper along the line that under certain conditions other fireproofing materials than concrete are equal to or better than this much praised and abused material.

To call the Mutual Life Insurance Building of San Francisco a typical building and proceed to argue that hollow tile was a failure and therefore all fireproofing of hollow tile is worthless is most unfair

[1] Supt. of Construction, National Fire Proofing Co., New York.

when scores of buildings have been subjected to fire which completely destroyed the interior and yet left the hollow tile floor arches practically intact. It is impossible for any one to say just how much of the damage to any of the buildings in San Francisco was done by fire and how much by the earthquake, but it is fair to assume that many thin partitions of hollow tile were thrown down by the shocks.

Mr. A. L. A. Himmelwright, member Am. Soc. C. E., in his report on the Mutual Life building for the Roebling Construction Company said:

> The floor arches are in fair condition. There are many places where the soffits of the tile blocks have fallen away, exposing the cellular spaces. The partitions are badly damaged throughout, a large proportion of the blocks having fallen down. Safes also caused the failure of some of the floor arches in this building. The column protection having been set independently of the partitions, is in fairly good condition. Some of it has been forced away by bulging pipes but the columns are apparently uninjured. The fireproof floors are 9-in. end construction hollow tile flat arch blocks with skewbacks of side construction. The shells and webs are $\frac{5}{8}$ in. and $\frac{1}{2}$ in. thick respectively. The partitions are of hollow tile blocks. The column protection is of 3-in. hollow tile blocks. Comments: This building exemplifies very forcibly the necessity of protecting large trusses in an efficient manner. The protection should consist of some material which will remain in place and which can be rigidly anchored to the structural members. The failure of the fireproof protection of the trusses is no doubt responsible for the entire damage to the two upper stories of the building.

We see from the foregoing report that the Mutual Life building was not an example of first-class hollow tile fireproof construction. In the first place the arches should have been at least 12 in. deep for the spans used instead of 9 in. and the shells and webs should have been $\frac{3}{4}$ in. and $\frac{5}{8}$ in. instead of $\frac{5}{8}$ in. and $\frac{1}{2}$ in. and of semi-porous instead of dense material. The partitions should have been not less than 4 in. on all floors except the first which should have been 6 in. The members of the trusses should have been fireproofed with porous material 2 in. thick applied and anchored securely to the steel.

It is a well-known fact that many other buildings of hollow tile fireproofing in San Francisco were repaired at very little expense and were occupied within a few days after the fire. This was true of the Union Trust Building, as to floor arches; the Mills Building, which cost about 5 per cent of the original cost to repair arches; the Flood Building and others not so well known.

The author states that no structure of the future should contain any wood. This is good doctrine and is attainable. Had the

Mutual Building contained no wood, there would have been little damage except from the earthquake, whether it had been built of stone, brick, hollow tile or concrete, but with all the advantages of beauty and quick construction in favor of steel frame, brick and terra cotta exterior with hollow tile fireproofing.

"With metal forms and certified concrete, concrete construction is cheaper today than brick, hollow terra cotta tile or any other material." This has been the dream of Mr. Edison for many years but we do not see many poured houses. Progress along this line will undoubtedly be made for factory building construction, for farm buildings and where rigid economy at the expense of all attempt at ornamentation is imperative. There has not to my knowledge been produced a system of metal forms which can be used to meet the varying conditions of floor arch construction at a less cost than for wood centering.

There may be yet some factory owners who would pour a group of houses for his employees from one set of molds but that day is rapidly passing for "The Town Beautiful" is an accomplished fact and ugliness for the sake of cheapness will not be tolerated. No individual owner who is able to employ an architect would accept a stock design for his building.

Flat ceilings are most desirable. This can be best accomplished, not by solid slabs of concrete, but by a combination of hollow tiles and reinforced ribs of concrete. For equal strength this type is the lightest and cheapest and most generally used.

"Metal moulds have reduced the price of concrete to that of wooden construction." This may be done in the future but it will probably be done only when wood is dearer than at present and when the design of the building is made to fit the forms rather than the forms made to fit various designs of buildings.

"Concrete hauled in large quantities from a centrally located factory and poured at once for the entire story of a building." Where has this been done?

"A concrete building is cooler in summer and warmer in winter than any other kind. It is drier than any other provided it is built with self-ventilating air spaces in all exterior walls." A solid concrete wall is cold and damp at all times unless the walls are furred. If built with hollow walls it is very expensive. A house built of hollow tile blocks with cement stucco on the exterior is the ideal house for what is above claimed for the concrete house and is very much cheaper and more artistic.

I object to the statement that concrete is the only rival to wood in low cost. This can be proved erroneous in view of the fact that hollow clay tile under many conditions is cheaper than concrete. Competitive bids on reinforced concrete and steel frame with hollow tile for the same building have frequently been made and generally in favor of the latter construction when the building is more than four stories high and time of completion is an element in the proposition.

The claim that concrete walls can be poured in metal molds with sufficient accuracy to permit of painting and wall-papering without plastering or smoothing, is another dream of the enthusiast which has not yet come to pass. Warehouses and factories may have their walls and ceilings white washed and let it go at that, but dwellings and office buildings, schools and institutions to be inhabited by people require a better finish than it is possible to make by any known method except at a cost much greater than plastering.

As to the damage by fire in concrete buildings, the pamphlet "Trial by Fire at San Francisco, the Evidence of the Camera"[1] proves that reinforced concrete suffered even more from fire than hollow tile but less from earthquake. I thoroughly agree with Mr. Gilbreth's arguments that fireproof construction should be exclusively employed and the use of wood, as far as possible, abandoned.

Each building proposition should be considered as a separate problem and the best solution sought. When concrete material is convenient and cheap, the building plain and rectangular for factory or warehouse purposes and not too high, and there is no great hurry for its completion, then possibly concrete may be used to advantage.

In the city where all the conditions are different, then the steel frame constuction with brick curtain walls with tile arches and hollow tile partitions is best and cheapest. Country and suburban houses can be best constructed of hollow tile, interior partitions of hollow tile, floors of combination arches of hollow tile and reinforced concrete, cellar walls of concrete.

Charles T. Main. Mr. Gilbreth notes that the United States is paying a preventable loss of more than $366,000,000 annually, this being the difference between European losses and those in our own country. The estimated cost of private fire protection, including capital invested in construction and equipment, is $50,000,000 with

[1]Published by the National Fire Proofing Co. Now out of print

an interest account and watchmen's cost amounting to $18,000,000 more. It does not seem possible to omit very much of the public fire-fighting apparatus and systems or the private investment, for this purpose, even if every building were proof against destruction by fire inside and outside, because the combustible contents of city buildings and factories make it necessary to put in hydrants, sprinkler and pumping systems and to maintain fire departments in the same manner as they are now installed and maintained. The spreading of fire would be reduced and the losses decreased accordingly.

In textile mills the value of the buildings is not more than one-quarter of the total value of the property, and the value of the property and of the stock in process is also a very considerable amount. In some of the rooms in a cotton mill the stock in process is very inflammable, and a fire will start from a spark or a heated bearing on a machine and go from one end to the other almost like a flash of gun powder. The insurance companies therefore require, even in fireproof buildings, a system of fire protection of the same capacity and efficiency as is required in buildings of slow-burning construction. As the losses on the contents of the buildings form a large part of our fire losses, it would be well to look for better regulations in regard to the storage of combustibles in our city buildings, including the retail stores.

In regard to the statement that fireproof buildings can be built as cheaply as those of the slow-burning type, I would say that in competition for a mill building recently, I obtained prices showing the cost of the concrete building to be about 25 per cent more than for regular mill construction. This is probably due to the fact that the floor loads in textile mill work are comparatively light.

In regard to the statement that if a whole floor can be poured at one time engineers can figure the textile strength of concrete when designing, I understand it to be meant that that portion of the concrete below the neutral axis down to the rods can be figured for tension. Investigations in this country have generally shown that when a beam is loaded much in excess of its ordinary working load, the concrete below the neutral axis cracks. As the assumed working load limits may often be exceeded, especially in factories, such cracking might occur, and then the beam would not have the tension factor which it was designed to have. Test loads would almost always destroy the tensile strength of concrete below the neutral axis, and many other conditions which will occur in the best actual construction will also help to destroy it. It has been my experience that concrete cannot

be made with sufficient scientific accuracy in the field, and voids, cracks, etc., will sometimes occur.

It is claimed that with the use of metal forms, mechanical handling and placing concrete, satisfactory work and good appearance can be obtained by omitting all wooden trim, casings, etc. This claim is far in advance of the work which most of the contractors have been able to produce. Most of them are wholly unable to come anywhere near to what would be termed certified concrete.

Any educational work which the Government could do for the people along the line of fireproofing buildings and houses would be eminently proper and useful, but it does not seem as if the Government could place any taxes or restrictions on the use of wood or other materials which enter into the construction, since the supply of materials and knowledge of workmen is so varied in different parts of the country. If any legal steps were to be taken along this line, they should be taken by the separate States instead of by the Federal Government, and even then the conditions are so varied in a single state that it would be impossible to cover all cases.

Every engineer and business man should be in sympathy with most of the statements regarding the reduced cost of construction of fireproof buildings and improved quality of workmanship made in the press, and should hope that some day they may become common practice.

E. E. Seyfert.[1] That no structure of the future should be built of wood and no structure of the future should contain wood is a conclusion which undoubtedly represents the means of preventing the enormous annual loss of property and life through destruction by fires. The fulfilment of such conditions will reduce the immense annual outlay of funds for fire protection and will be the means of solving the problem of conservation, as applied to the use of the metals and timber as materials for general building construction and engineering work.

The incombustible material which shall replace wood in building construction, is generally conceded to be concrete, a material capable of resisting high temperatures for longer periods, without injury, than brick, stone, metal or wood. It is obtainable everywhere at low cost and the labor necessary for its use in construction is of less cost than for any other building material. Concrete reinforced with

[1] Chief Engineer, Pittsburgh Steel Products Co., Pittsburgh, Pa.

metal is without limitations as applied to engineering structures. The combination of these two materials has established the ideal building material, as determined by its phenomenal development, both as to the amount built in each successive year and as to the variety of applications.

The theory concerning the mode of action of the two materials involved in reinforced concrete has constantly undergone modification, perfecting itself through deductions from experiments. The theory of such action at the present time is well established. As a matter of fact, more is actually known about the carrying capacity or the ultimate resistance of concrete steel members than about the carrying capacity of similar structural steel members. A great mass of well-considered and well-digested experimental data has been accumulated from full-size tests of both concrete steel beams and columns, perfecting the knowledge of their design and construction. On the other hand, no tests of full-size columns of structural steel exist from which it is possible to obtain data governing even the fundamental principles of design. Is it not, therefore, reasonable to assume that more confidence should attach itself to the consideration of the ultimate capacities of concrete steel members, beams and columns, of scientific design, as determined from actual tests, than to the computed ultimate carrying capacity of steel columns without determining experimental data.

It has for a long time been a recognized fact that to obtain reliable results, combined with efficiency and economy, in reinforced concrete construction, there must exist rational design, good cement, steel of standard specification, intelligent and effective handling and good inspection. These factors have not at all times been employed in construction. Accordingly the tendency of the profession has been in the direction of standardization of each element, a standard specification governing the quality of the material of each and method of its use. There has been placed upon the market recently a standard reinforcing unit frame, scientifically designed and standardized. It provides the depth of slab, beam or girder, designates the required unit frame, for any given load from 40 lb. to 600 lb. per sq. ft. of floor surface and for spans of beams or girders varying from 6 ft. to 30 ft. Columns, footings, rectangular beams and T-beams are standardized. The condition no longer exists, as Mr. Gilbreth pertinently remarks relative to the early development of reinforced concrete.

The materials of the present day which enter into the construction

of reinforced concrete work are generally reliable. The ultimate success, however, of this class of work is almost exclusively dependent upon the proper placement of the metal reinforcement, provision for shear or diagonal tension by a system of rigid web reinforcement, careful handling, competent superintendence and rigid inspection.

It is almost a presumption to call the attention of engineers to the danger of the displacement of reinforcement in concrete work. Concisely stated, if the displacement is upward, there is a loss of strength proportionate to the amount of such displacement; if the displacement is downward, the fire-resisting qualities of the concrete are vitally impaired; also with reinforcement too close to the surface the dangers from electrolysis arises. It is the opinion of the writer, however, established upon experience, that it is necessary to call the attention of engineers to the necessity of making provision for the prevention of such displacement. It has become a fact that no matter how carefully separate bars or loose rods are placed in the forms, or what precaution is taken in the pouring of the cement, there can be no definite assurance when the work is conpleted that the metal is either in the proper position or in the quantity called for by the specifications. Cases have been actually observed, even with the most perfectly organized forces, where a rod or two have been accidently omitted from an important member, or where a short one has been thrown into the work to take the place of a lost longer one. The only certain method of overcoming this difficulty is by the use of a reinforcement fabricated in units and the application of such unit reinforcement should become compulsory.

The subject of shear or diagonal tension in beams and girders should be given greater attention by engineers. If it is unsafe to count on the tensile strength of concrete to resist horizontal tension, it is equally unsafe to count on it for diagonal tension, or for shearing stresses in the web. Diagonal tension failures are the greatest dangers to be feared in this class of work. In practice nearly every beam failure is of this kind. Many empirical systems have been produced, consisting of units composed of loose rods with wire stirrups, loose and unsupported bars with sheared edges and others in which no provision has been made for slip of web member other than the adhesion of the concrete. The fact that these systems have produced buildings which have not collapsed under load is no proof of the adequacy of their reinforcement. It is perfectly obvious that the formation of cavities in concrete will take place and that such formations are very nearly impossible to guard against during

the operation of pouring and tamping of concrete in complicated units of loose bars wired in many directions. The solution of the problem is achieved, as determined from recent tests, by placing all web members at an angle of 45 deg. to the horizontal, and rigidly connecting them to a top horizontal bar and to the bottom horizontal tension member, thereby absolutely fixing them in position and eliminating all tendency to slip when in stress under the action of load or shock.

C. A. P. Turner.[1] As regards cost, Mr. Gilbreth is correct in his statement that reinforced concrete in the central and eastern sections of the country, economically designed, is fully as cheap as first-class timber mill construction where the floor capacity is 200 lb. per sq. ft. with column spacing about 20-ft. centers. Where the capacity required is less than 200 lb. per sq. ft., light timber construction will cost slightly less, but the difference in general is too small to warrant the risk for the majority of commercial purposes.

Many engineers are inclined to question the fire-resisting properties of concrete when made of suitable aggregate. Take for example the heat of the acetylene-oxygen blowpipe, something like 6500 deg. This would cause the ordinary piece of burned clay to crack, but turned on a 3-in. block of good gravel concrete has little more effect than the production of a minute puddle of molten glass directly under the point of the flame, which as soon as the flame is removed cools and sticks to the portion of the concrete so treated. The action of concrete under such high temperatures will naturally vary with the character of the aggregate. Where it is silicious in character, comparatively little damage will be done by long continued high temperatures; where of granite, splitting and spalling may occur; where of limestone, some of the limestone may be injured by the extreme heat, though this process is extremely slow.

One of the greatest causes of injury to the building made up of incombustible materials during a conflagration is the unequal expansion and contraction of the materials entering into the make-up of the building. For example, with steel beams and hollow tile fireproofing, the steel and tile do not expand and contract at the same rate. The result is frequently shattering of the hollow tile, leaving the so-called fireproof floor in a dangerous condition.

With reinforced concrete the effect may be, where thin beams or

[1] Cons. Engr., 816 Phœnix Bldg., Minneapolis, Minn.

ribs are used, to dehydrate or damage the projecting ribs where a part of the construction may be overheated without correspondingly overheating the main portion of the floor. Where, however, the floor is of a thick plane flat slab of reinforced concrete the effect of the high temperatures and subsequent chilling by turning on the hose is comparatively slight.

A fire test was conducted in Denver, in which two loads of pine wood split into faggots about 2 in. sq. and drenched with oil were used. A very intense heat was secured within 5 ft. of the under side of the slab, which was heated in the course of a half hour practically to a white heat. The hose was then turned on and the fire extinguished. No material damage resulted to the slab in the case of two tests when it was loaded to more than twice its normal working load, the spans being approximately 20 ft. A third test was made on the concrete in a partially cured state. The aggregate in this instance was a sandstone metamorphosed almost to a quartzite, but containing veins where the material was porous. The slab in this instance not having thoroughly cured, steam was generated in these veins and caused the rock to pop or explode with a noise like a pistol shot, breaking or spalling out to a depth of about 1 in. under the surface of the slab over an area of about 2½ ft. in diameter. The fire in this case was very intense, but the carrying capacity of the slab was practically uninjured, although some permanent set resulted, due to the elongation of the steel under heat. This permanent set was in the neighborhood of ⅜ in. in 20 ft. Duplication of this test on an adjacent panel after the concrete had been given ample time to cure resulted in no damage whatever. Test of the quartzite in an assayer's furnace showed that it could be heated to a white heat and then quenched in cold water without injury, while smelter slag, granite and gravel samples, subject to the same treatment were reduced to powder.

It is evident that a fire test like this may be considered fully equal to anything which would ordinarily occur in a fireproof building. The damage to the building would be practically nil and the real need for insurance is more to protect the contents of a properly constructed concrete building than to protect the building itself.

The writer regrets to note that there is a tendency among insurance companies to discriminate against concrete in favor of inferior types of fireproof and even combustible construction. For example, the ordinary mill building with a sprinkler system is rated on almost the same basis as the concrete building. Why any building of this

construction, which will make the hottest fire when once started, should receive the benefit of rates lower than one which is practically impossible to burn is rather hard to understand. The owner of a concrete building is well aware that his building is practically indestructible and while it may be damaged by smoke and the contents be lost, he is satisfied that he will not lose the building and declines to pay an unreasonable rate of insurance.

Going further into the matter of cost, the writer has long advocated the simplification of the centering and use of flat floor construction as being most economical, most readily erected and the most satisfactory from the fireproof standpoint. Where, however, the building is low, the loads, such as roof loads, are light, and the spans long, it is possible to put up independent beam construction with light roof slabs cast separately and erected in place without forms at a lower cost than it is possible to build of monolithic construction. This type of construction has been utilized for car shops and the like in many parts of the country with success.

Some of the advantages of reinforced concrete from the fireproof standpoint are not apparently well appreciated. As the concrete gets older and harder its fire-resisting properties increase. Poor mixtures, lean concrete and bad work do not make a first-class fireproof building in reinforced concrete any more than a poor mixture, insufficient thickness, lack of proper ties, render concrete a suitable fireproofing for structural steel frame. It is an unfortunate fact that many of the structural steel frames encased in concrete are by no means fireproof.

Some months ago the writer, while visiting the city of Denver, noted a 12-story building in which so-called concrete fireproofing was used. The architect had adopted a full structural steel frame, believing that reinforced concrete was not reliable from the standpoint of strength, yet he had sufficient faith in concrete as a fireproof material to adopt a thickness of casing around the structural steel column barely thick enough to cover the rivet heads. This was on a plate approximately 18 in. wide. Such fireproofing, even though it be of concrete, can hardly be regarded as other than a joke and the sooner insurance companies adjust their rates to correspond with the risk, the better it will be for them from a business standpoint.

To those in the central and western portions of the United States it seems to be a fact that eastern cities, particularly New York City, are decidedly backward about adopting up-to-date methods of fireproof construction. This statement is based in the building regula-

tions of the cities in question and it is seemingly having an unjust influence, perhaps, in the judgment of the members of the engineering and architectural professions in the cities where such rules are in vogue. The tendency of the investor, after seeing the success under more liberal codes, is to conclude that the professional architects and engineers located in cities presenting unreasonable requirements are responsible therefor and the tendency is for the investor to lose confidence in the professional talent of the locality in question. He argues, with some degree of justice, that unreasonable ordinances would not be in force were they not supported by the more influential representatives of the engineering and architectural professions of the city in which they are in vogue.

George G. Hopkins, Jr. Some of the pictures shown illustrated many of the common defects in fireproof construction, the chief of which were lack of protection at window openings and inadequate protection of floor openings. It is perfectly possible, by protecting all door and window openings, including those in courts, by tin-clad wood fire shutters, by corrugated iron shutters made on standard angle iron frames or by wired glass in hollow sash windows, to prevent an outside fire entering a building. A group of such buildings would furnish the best stop to any conflagration. If the fireproof buildings in Baltimore had all their window openings protected they would doubtless have escaped and done much to check the flames. Of course the advantage of protecting exterior openings is not confined to fireproof buildings.

The protection of the floor openings, stairs, elevators, etc., is of the greatest importance, and the general principle to be borne in mind is to make the enclosure of all floor openings equal to the floors. A chain is no stronger than its weakest link. So it is little use to build partitions of terra cotta blocks and then put in thin glass transoms and sidelights. It is equally useless to build an elevator shaft and use crimped iron doors on light flat iron frame that will warp out of shape the minute a fire touches them. It is just as bad to put tin-clad fire doors on a wooden stair enclosure. Stairs and elevators can easily be inclosed by brick shafts with underwriters' standard tin-clad fire doors at the openings to the floors. With the best modern practice favoring electrical power transmission, belt holes can be entirely eliminated or a vertical power shaft made to pass through close-fitting bearings in the floors can be provided.

DISCUSSION AT ST. LOUIS

E. D. Meier said that the difference in climate and in the habits of the people here and abroad has important bearings on the question of fire loss and fireproof construction. In this country great quantities of inflammable material, such as hand bills, theater programs, boxes of matches, etc., are given away quite freely and as a consequence, our streets are littered with this material. Then our climate is much drier than that of the European countries with which comparison is made. When these conditions are combined with the careless habits of smokers who drop unburned matches in public places, the danger from fire may readily be seen. In Europe such material is not given away so freely; everything, whether it be a theater program or a box of matches, has a definite value and is not thrown carelessly about in public places, considerably reducing the quantity of inflammable material.

He further said that he did not believe in buildings erected without inflammable material nor in those built largely of wood, but preferred a middle course, such as wooden doors enclosed in steel or copper sheathing; neither did he believe concrete window sashes to be practical.

He said he was a great believer in concrete, but in a building containing a large quantity of inflammable material such as a library, an office building or a dry-goods store, no matter how well it may be constructed, he did not consider it safe without a sprinkler system in addition. Probably the best construction would combine a concrete building with the sprinkler system.

James Waterworth.[1] I agree with Col. Meier in that the difference in climate and in the temperament of the people, as well as in the type of construction, make deductions drawn from the experiences in Europe and in this country comparatively valueless. One of the largest dry-goods companies in St. Louis, operating a very large store with inflammable construction and contents, was paying 2 per cent a year for insurance, making their annual premium $10,000. An even larger store in Glasgow was obtaining the same amount of insurance for $700. This great difference is due partly to the climatic conditions, which leave the wood and other materials in the building not so susceptible to immediate ignition as in this climate, where wood is dried to a condition permitting rapid combustion, and partly

[1] 523 Odd Fellows Bldg., St. Louis, Mo.

to the difference in the habits and temperament of the people. For these reasons it will hardly be possible to obtain in America by means of any form of favorable construction or protection results that similar construction would secure in Europe.

It is hard to convince an insurance man that any building is fireproof and I question whether any mercantile building containing large stocks of dry goods can be made fireproof without destroying the mercantile features of the building. It may be possible to construct a fireproof building in which the material can be consumed without damage to the building, but it then ceases to be a place suitable for the display of goods.

Many of the new buildings in St. Louis have steel skeleton frames protected with tile and have tile floors. I do not consider that the best fireproof construction for a building containing a great quantity of fuel in the shape of merchandise. We have reached the concrete stage and have a very notable example of that construction in the Butler Building and we recognize its fitness. This building, covering the entire block, eight stories high on one side and seven stories on the other, would carry an extremely high insurance rate except for its reinforced concrete construction. The insurance on the building has been placed at the rate of 9 cents per $100 per annum on account of its fireproof qualities of construction. That is the response of insurance to the new concrete construction.

I regret to say that a factory is soon to be built in St. Louis of mill construction in preference to concrete. This seems to bear out the statement that concrete construction is not yet so cheap as mill construction or that the rules governing the construction of concrete buildings are too exacting.

It is true that a building of mill construction properly equipped with automatic sprinklers gets a better insurance rate than a concrete building not so equipped. Experience has shown that the average loss ratio of buildings equipped with automatic sprinklers is less throughout the United States than that of fireproof buildings not so equipped. The use of good concrete construction in an office building would make it practically fireproof were it not for the fact that every such building contains a great funnel formed by the stairway and elevator shaft from top to bottom of the building. No building can be considered fireproof where there is free communication between the floors through which the fire can travel. Under these conditions even a fireproof office building may be destroyed or nearly so by the combustion of the furniture and papers it contains.

The word fireproof is a relative term and must always be so used. I doubt very much if a building like the Ely Walker dry-goods store, containing 30,000 sq. ft. of floor space open from end to end and entirely filled with merchandise, can be made absolutely fireproof, and question whether any building ever constructed for mercantile purposes would stand the combustion of its contents without great damage to the structure. But we can have fireproof dwellings and apartment houses if we choose to build them properly. I believe there is no doubt that concrete is the coming building material.

A. B. Greensfelder[1] said that one of the most amazing things to the constructor is the fact that the Fire Prevention and Insurance Bureaus are seldom consulted regarding the details of the construction before a building is erected. The usual procedure is to go to the Insurance Bureau after the building has been completed and ask for an insurance rate. When an inspection of the building shows the errors committed from an insurance point of view, changes are necessary to meet the insurance requirements. It would be much more economical to submit the plans to the Insurance Bureau or Fire Prevention Bureau for approval before the work is started.

He thought the vital difficulty with reinforced concrete construction is that we do not think in terms of concrete, but rather in terms of the more familiar materials such as structural steel, brick and timber, making our concrete conform to the construction required by these other materials. It will probably be in the next generation that concrete will be considered as a material by itself, and when that stage is reached marvelous results may be expected.

The construction of the present day is very crude. For instance, in erecting a reinforced concrete building, wooden floors are frequently employed which can never be considered fireproof although certain measures can be taken to make them fire resisting. Unit construction is now being developed, but has not yet been widely employed. Very little has been done to embellish concrete buildings, especially regarding the use of colors. In the city of Havana, Cuba, white buildings are prohibited on account of the effect of the reflection of light from the walls of such buildings. As a result, all the buildings employing stucco-concrete are in colors. Local conditions make this a cheap construction and the color scheme is very good.

Reinforced concrete has served a good purpose in bringing engineers

[1] Fruin-Colnon Contracting Co., St. Louis, Mo.

into building construction, resulting in a greater amount of scientific study along these lines, but some of them are too optimistic about the possibilities of concrete. In the papers of ten or fifteen years ago we find the same enthusiastic hopes that steel would supplant wood, but steel has found its place and concrete is merely another material that will also find its particular place.

H. Wade Hibbard spoke of his experiences in building a low-cost small wooden residence of slow-burning construction. After consultation with his architect, a slow-burning structure advocate, certain measures were determined upon with this end in view. The architect advised him, however, that it would be impossible to secure from any builder the faithful performance of such work that was out of the ordinary procedure in building construction. He was therefore obliged personally to oversee the work and even to perform some of it himself.

The steps taken to assure slow-burning construction included the setting of all wall and partition studding for the upper stories on a two-by-four laid on the floor below. The studding of each story had a two-by-four laid on top. In this manner a fire within the partitions and walls would be retarded at each floor by having to burn through 5 in. of wood. The flooring was in all cases made double, both rough and finished being matched, with either tin, sheet iron or usually slow-burning paper between, according to the danger above and below. All holes made through floors for plumbing or wiring were filled with brick and mortar. To delay a fire from passing out of the rooms into the partitions, all cavities for sliding doors were lined, and side plastering was carried down to the floor behind the baseboards. Of course such door cavities had sheet iron placed between rough and finished flooring. The next house he builds will have wire glass in the upper half of the windows. The chimney, lined with rectangular chimney tile, cemented end to end, was placed on the outside of the house and where it touched the wooden siding, six thicknesses of asbestos paper were inserted with joints broken. The same method was used around the fire place and its flue. The electric wiring, while kept inexpensive, was given special attention in the specifications, by the owner, architect and insurance inspector. Hot-water pipes for heating and for water service were wholly exposed. The heater was a steel boiler internally fired, without brick work, its top being some distance from the ceiling.

The kitchen, where there was a coal range, was partitioned off from

the rest of the house by laying two thicknesses of almost incombustible seaweed building quilt in and out between the double zigzag line of studs. The double-rabbetted door between the kitchen and library was made of two thicknesses, with a layer of this quilting between. Quilting was used instead of sheet metal as a sound deadener.

Matches of the sort to be ignited on the box were placed out of convenient reach and permitted in the kitchen only. Oily rags and cloths for waxing floors and standing finish were kept in an incombustible receptacle. A fire extinguisher was placed convenient of access in the main hall; and in the basement, kitchen and bathroom ordinary garden hose were coiled ready to be attached instantly to hose faucets. The nearest house was over 100 ft. away and a slate roof seemed unnecessary, but exterior hose bibs were placed on both sides of the house.

As a result of these precautions against fire, this house was granted an insurance rate as low as that for a brick dwelling with a slate roof situated next to a fire company, instead of the maximum rate which is usually placed on suburban frame residences with poor fireproof protection.

Professor Hibbard advocated initial and occasional inspection by insurance companies carrying dwelling house risks, in order to lessen fire losses. Splendid results have thus been attained by the well-known factory mutual fire insurance companies.

The Author. Answering H. De B. Parsons, who states that the more fireproof a building is made, the greater will be its cost and the less its utility for modern demands, this is not always so, as is shown by the residence of Henry C. Mercer, Doylestown, Pa. (Figs. 28-31). Where Mr. Parsons cites unprotected columns failing from heat, he makes two very good illustrations of the difference between buildings of incombustible material and fireproof buildings. It is this distinction, so little understood by the average owner of buildings, that has caused the fire havoc in America.

Mr. Woolson's criticism of a centrally located concrete plant, that for efficiency and economy it would be necessary for such a plant to be in continuous operation, makes the point that I tried to illustrate the more obvious, namely, that such a plant would be in more nearly continuous operation than the plant of any small job. On a small job where labor is plentiful, it is more economical to put form builders to work until an entire story is ready to pour and then to lay them off than to use them at a higher rate of wages

per hour than that of the concrete laborers. The reinforcement men may then be set to work, followed by the concrete laborers, and lastly by the cement finishers. Thus, for greatest economy on a small job, the mixing plant is in action intermittently, with all the inefficiency and wastefulness that accompanies any management that is continually disturbed, disrupted and changed.

On large jobs, the fact that a plant in continuous operation is most economical is so well realized that central mixing plants are the rule

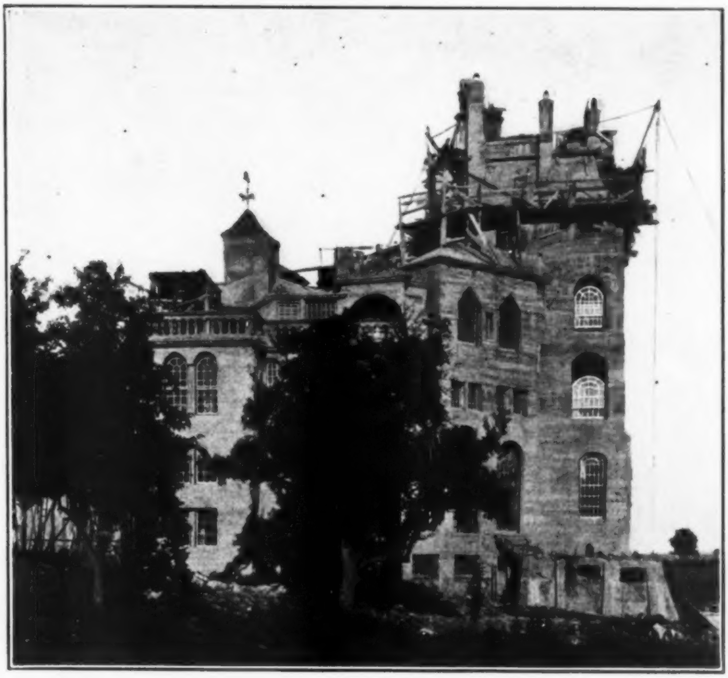


FIG. 28 RESIDENCE OF HENRY C. MERCER, DOYLESTOWN, PA., BUILT OF CONCRETE

in many places, such as in the construction of the New York and Boston subways, where a central mixing plant was located in Post Office Square, a few blocks away from the nearest approach to the subway. The large mixing plants on the New York barge canal are good illustrations of central mixing plants.

Such a plant has a great chance to operate continuously, because when work is interrupted at one location by a cave-in, change of operations, strike, lockout, change in plans, delay of reinforcement forms,

weather or any other cause, the plant has just so much larger territory of working opportunity from which to draw. Furthermore, the total cost of mixing concrete by hand is often exceeded by that of machine mixing on small jobs by the burden of such fixed charges as hauling the mixing machine to the job, setting it up, operating, taking it down and removing, all of which is done but once on the centrally located plant. There is a large mixing plant at Man-

Fig. 29 Residence of Henry C. Mercer, Showing Interior Decoration

hasset Bay, Long Island, for mortar for supplying New York City.

In reply to Mr. Woolson's statement that as a general proposition it is very difficult to make a handsome strictly fireproof dwelling and have it satisfy the artistic taste of the architect and owner, this was once quite true, but is no longer so. One need only visit the house of Henry C. Mercer to see that at last, an artist, maker of the famous Mercer clay art tile, has shown the way to make an artistic large or small concrete house, absolutely fireproof from every

standpoint, at no greater expense than the cost of a wooden structure of the same size. No amount of fire from the furnishings of such a house could do more than a nominal damage that could be repaired at a nominal expense. There are no passages for fire, and almost no wood is used. The completion of the structural parts of the house was celebrated by a bonfire of the form lumber on top of the roof. This residence has done much as an object lesson of permanency, low cost, fireproof and artistic effect combined. Mr. Mercer has shown

FIG. 30 RESIDENCE OF HENRY C. MERCER, SHOWING CEILING DECORATION

that this result can be obtained with inexperienced labor. He has also eliminated the necessity of fire insurance on or in a dwelling. His house answers Mr. Woolson's argument.

The statement made by Mr. Woolson that if the two or three conditions which are necessary to start a conflagration ever occur simultaneously, we will have a fire horror in this city which would discount the records of Boston, Chicago, Baltimore and San Francisco, is true. All who have studied the fire situation agree and know it to be true.

Mr. Woolson is the acknowledged authority on the relative combustibility of building material of the different kinds of construction. His experiments of burning many full-sized building units cover a long period of years, and the conclusions arrived at by him and by Mr. Macgregor of Columbia University are world standards today. *Remember his prophecy regarding the great fire that will some day destroy New York if we do not change our building methods.*

Replying to Col. Meier, there can be no question regarding concrete window frames being practical. One of many instances where concrete window sashes may be seen giving remarkable satis-

Fig. 31 Residence of Henry C. Mercer, Details of Interior Decoration

faction, is shown in Fig. 32. They are permanent, fireproof, and even burglar-resisting. When their full benefits are appreciated the design of windows in our buildings will be changed. Col. Meier is undoubtedly correct when he states that the best construction would combine a concrete building with a sprinkler system.

Answering Col. Meier and Mr. Waterworth, the writer desires to call attention to the fact that their remarks as to difference in climate add force to the arguments in favor of the necessity of using less wood in American buildings. The dryness of our climate makes wood

very susceptible to immediate ignition, but not so with brick, steel, or concrete. The habits and temperament of the people will not be a serious factor after wood in construction has been entirely eliminated.

Fig. 32 Residence of Henry C. Mercer, Showing Concrete Window Sash

In answer to P. H. Bevier, who represents the combined manufacturers and dealers in hollow clay tile blocks, the writer desires to state that this paper was written after his having been personally in charge of laying hollow tile blocks of every description and also of concrete work since the year 1888. He has no reason, after reading Mr. Bevier's remarks, to revise any portion of his paper as printed.

For additional corroboratory evidence of the true condition of building materials, those interested should send for Bulletin No. 324, published by the United States Geological Survey, entitled The San Francisco Earthquake and Fire of April 18, 1906, and their Effects on Structures and Structural Materials. This book was written by the following well known experts: Richard L. Humphrey, Secretary of the National Advisory Board on Fuels and Structural Materials; John Stephen Sewell, Corps of Engineers, U. S. A.; Frank Soulé, Dean of the College of Civil Engineering of the University of California; G. K. Gilbert of the United States Geological Survey.

Examine Plate 25 *B* of this bulletin and see the concrete work on the Academy of Sciences Building. This building has been generally overlooked in the discussions regarding the resistance of good concrete to fire. It is an ideal example of complete concrete work remaining intact so that it would require no more than mortar and a plasterer's trowel to restore any of the concrete work. Had the entire city been of the same construction no unprejudiced person believes that the great catastrophe of the San Francisco fire would ever have occurred. This building is the work of Ernest L. Ransome, the father of concrete in America. It was the first commercial building with reinforced concrete floors in the western hemisphere and is a monument to Ransome that will ever be remembered by those who saw it and particularly by those who tried to take it down after the fire.

It must be remembered that Mr. Himmelwright's opinion, quoted by Mr. Bevier, regarding the Mutual Life Insurance Company's building, was based upon observation of the building after the fire, while the statements of the writer are based upon having seen it daily for weeks during the process of taking the building down piece by piece without succeeding in obtaining enough tile that would stay in one piece long enough to make one load to be sold as second-hand material. Mr. Bevier is quite correct in saying that the Mutual building was not a typical building from a hollow tile standpoint. It was not. It is one of the few buildings in which hollow floor and partition tile were used that did not suffer from failure of a large portion of the steel frame. In this building there was little or no failure of structural steel due to heat, except in the top story and other stories where the roof steel crashed through to the basement. Neither was there sufficient heat in the building to fuse any iron, nor to set the wooden flag pole on fire, nor even to scorch it or blister the paint on it.

Contrary to Mr. Bevier's remarks, it is possible to state with accuracy how much damage was done by the earthquake to the Mutual

building, for the writer interviewed a man who went through the entire building after the earthquake and before the fire for the sole purpose of securing this exact information. Furthermore, Bulletin No. 324 of the United States Geological Survey states on p. 43: "The damage to this building (the Mutual Life Building, Sansome and California streets), from earthquake was very slight. The fire in the building, while not severe, was sufficient to cause the failure of the tile fireproofing of the roof trusses, which collapsed from exposure to heat."

The Mutual building is "unfair" as an example of the fire resisting properties of its fireproofing because it did not have any water thrown by the fire department upon the hot hollow tile. The safes did not cause the failure of some of the floor arches, as no safes were found in the basement; but would a safe in a burnt building be sufficient excuse for a "fireproof" floor falling? Is not the first requirement of a fireproof floor that it will hold up everything on top of it during and after a fire?

Undoubtedly there will always be some people who desire to put the various kinds of pipes behind the fireproofing that surrounds a structural column. Can any material that will not resist the action of being forced away by the bulging pipes be called as good fireproofing as is concrete? Those interested in the subject of fireproofing should read all of Mr. Himmelwright's valuable report.

The Mills, the Union Trust and the Flood buildings "were occupied within a few days after the fire," by a watchman perhaps, but they were not repaired for over a year after the fire. The failure of the terra cotta to remain in place in the Union Trust buildings can be seen in the United States Geological Survey, Bulletin No. 324, Plates 40, 45 and 50. These three buildings that Mr. Bevier cites as examples of buildings repaired at very little expense and occupied within a few days after the fire, are also fully discussed in this same bulletin. Quoting from p. 41:

> The hollow tile failed and left the steel skeleton exposed to the fire. . . . . Owing to the failure of the floor tile, many safes fell through the several floors. The building should be rebuilt.

On page 78 is a description of Aronson building:

> The ordinary ten-story steel-frame structure at the corner of Third and Mission Streets known as the Aronson Building had terra-cotta column coverings and partitions and cinder-concrete floors, all of which were of the types described in this paper as common in commercial buildings. The building seems

to have been occupied for light commercial purposes, and the fire test to which it was subjected was therefore somewhat more severe than that prevailing in office buildings.

A column in the basement was buckled, and two of the columns on the first floor were badly buckled near the ceiling as shown in Plate 27 *B*. These results, so far as the condition of the fire-proofing is concerned, are typical not only of the other stories of the Aronson Building, but of similar work in other buildings throughout the burned district. Some of the work in the Aronson Building was not severely tested by the fire and was still intact. An examination of it shows that it was as well done as similar work in any other commercial building in San Francisco. Where the fire was not very hot this kind of fireproofing protected the steel and suffered not more than 10 or 15 per cent of damage itself; where the fire reached the average temperature the fireproofing suffered a loss of 50 to 100 per cent, and where the fire was a little hotter than the average the total loss of the fireproofing and serious damage to the steel work was not at all uncommon. Damage to fireproofing such as that here described occurred in the James Flood Building, the Emporium Building, the building of the Spring Valley Water Company, the Mills Building, and every other building in which hollow tiles were used.

On p. 47 the condition of the Union Trust Building is described:

The floors and partitions [of the Union Trust Company's ten-story building, Market and Montgomery Streets, were of hollow tile, and the girders, beams and columns were fireproofed with the same material. The floors were topped with cinder concrete covered with wood, except in the corridors, where cement finish was used. The cast-iron stairways had marble treads. The granite walls were spalled around the openings by fire. The hollow-tile partitions failed extensively and the lower web of the floor tile spalled over large areas. The fire was not intense, and the steel appeared to be in fair condition except on the ninth and tenth floors. . . . . The steel trusses on the tenth floor were very much distorted by heat, owing to the failure of the hollow-tile fireproofing.

On p. 147 is to be found the following statement:

Good Portland-cement concrete has won a triumph for itself in fireproofing in San Francisco, for wherever well-made and properly laid upon the steel girders or columns, it protected the metal. In very hot fires the exterior portions were disintegrated and in some places the whole mass was cracked, necessitating removal, but the fireproofing it furnished during the conflagration was excellent. Examination showed also that it protected well against rust. The heat to which it was subjected was very great, in places common mortar being fused and ironwork walls melted. * * * * * * * * * * * * *

As fireproofing for floors terra-cotta tiling has not given universal satisfaction. It is lighter than concrete, but the wrenching of buildings during the earthquake opened many of the joints and the mortar was destroyed—as in the Mills Building, a large ten-story steel-frame structure of the older type, hav-

ing self-supporting walls. The mortar joints in the tiling were started by the earthquake, and the mortar was disintegrated by the fire, the floors being destroyed and the lower surface of the tiling badly spalled. The same effect was noticeable to a certain extent in the excellent Union Trust, Crocker, and James Flood buildings. In the last named the flooring was fireproofed with terra-cotta arched tiles, covered with concrete on top and finished beneath by an efficient ceiling plastered on wire lath. The fireproofing was less injured in this building than in almost any other.

Terra-cotta fireproofing of columns was in many buildings a failure not so much on account of the nature of the material as because of its insufficiency in quantity and poor or imperfect method of application. Wooden studs were in many places put behind the terra-cotta. These burned out quickly, leaving the material unsupported. Pipes and wires were run up between the column and the fireproofing, and the twisting or expansion of the pipes caused by the earthquake movement broke the protecting cover. Imperfect junctions with ceilings above or floors beneath were common. That such imperfect construction should never be adopted has been fully demonstrated in San Francisco.

Plate 40 *B* shows the complete destruction of some fireproofing in the Mills building, together with the fact that its lack of fire protection resulted in one of the main columns of the building buckling and shortening several inches.

It is not the purpose of this paper to underrate the fact that hollow tile was a distinct step forward toward building with non-combustible material; but it has been stated that many buildings of hollow tile fireproofing in San Francisco were repaired at very little expense and were occupied within a few days after the fire, while two of the three buildings cited as the best examples, photographed and reproduced in the United States Geological Survey Bulletin, No. 324, record the fact, well known to those who were on the ground studying week after week the effects of the fire under different conditions on the different kinds of structural materials, that one could stand in the basement and see the sky. Although Mr. Bevier states that it was unfair to call the Mutual building of San Francisco a typical building, the same thing was true there. One could stand in the basement, look up through eight stories and see the sky with no obstruction except occasional bare iron beams.

The subject of this paper is fires, with the purpose of calling attention to the necessity, and practicability of eliminating wood in construction. Hollow tile is greatly preferable to wood, but Mr. Bevier makes some statements that are exactly opposite to the facts recorded by disinterested government experts.

Houses poured one story at a time are too numerous to cite. An

architect named Morrill has poured many houses in metal molds in Washington, D. C., each distinctly different from the others. With the exception of Mr. Edison, all metal-mold advocates use interchangeable molds that can be set up to form any size, shape, kind or combination of building. Metal molds can be obtained without delay from Morrill of Washington, D. C., Diedritch of New York, the Concrete Standards Company of New York and the Blaw Company of Pitts-

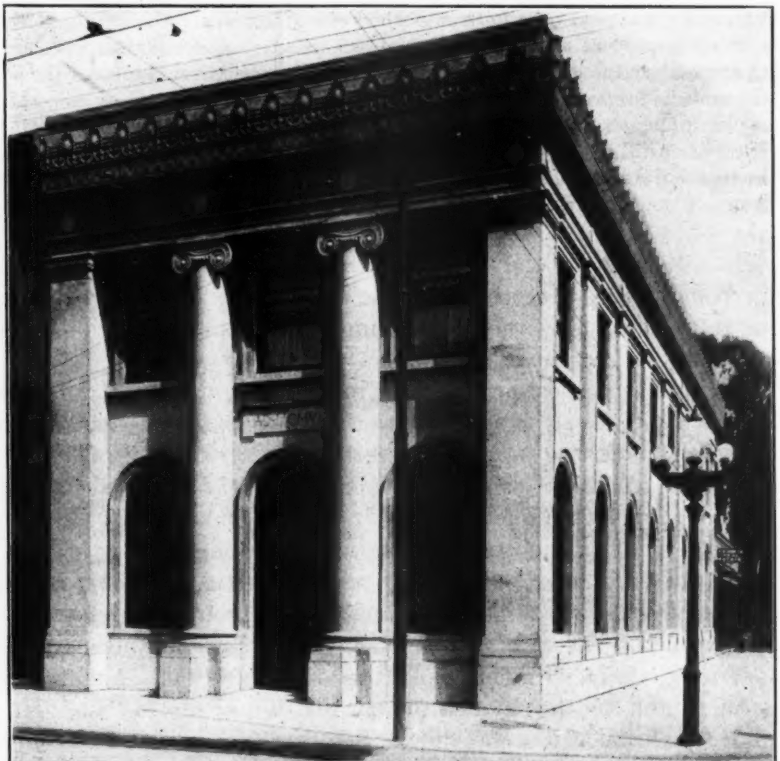


FIG. 33 CITIZENS BANK OF ALAMEDA, CAL., WHERE SOFT GLUE MOLDS WERE USED FOR ORNAMENTATION

burgh. Mr. Bevier should know that they are not new. The writer has used them over and over again, since as far back as 1896, and has found them economical and capable of producing a surface so smooth as to require no plastering.

Because of the use of metal molds there is no necessity to omit

ornamentation. Metal molds can be used and a core box built in the wall for inserting especially molded and especially carved ornamental blocks of partially set concrete. Furthermore, special molds of soft glue can be used when deep undercut is desired. A photograph of the Citizens Bank of Alameda, where soft molds were most successfully used for such ornamentation, is shown in Fig. 33. Metal molds, such as those of the Concrete Standards Company, made in three sizes of dies, will make any kind or shape of building. When a piece of ornamentation is necessary it is made in accordance with any of the practices used for any other kind of molds. Therefore The Town Beautiful that Mr. Bevier fears for is in no way affected so far as interchangeable molds are concerned, except that costs are reduced to a point that will afford more money for further ornamentation.

Mr. Bevier says that flat ceilings are most desirable. When flat ceilings are desired they can be made easiest, strongest, quickest and cheapest with some such form of construction as the so-called mushroom system invented by C. A. P. Turner of Minneapolis, Minn. This system, while noted for its strength, is mushroom as to speed as well as to the shape of its columns. A flat ceiling as designed by Turner has no beams to interrupt light, interfere with the action of sprinkler systems, or to take up head room. It has all the advantages of a buckle plate in strength. It is of low cost because it requires the simplest of forms. When made of concrete it requires fewer coats of plastering. There are no corners or edges to be injured by fire. It can be reinforced in four directions, that is, north and south, east and west, northeast and southwest, northwest and southeast. When Mr. Bevier sells his blocks for a combination of hollow tile and reinforced ribs of concrete, the reinforcement in ribs runs one way only, for example, north and south.

If one desires to use hollow blocks with ribs of concrete, there can be obtained most excellent hollow tile made of concrete by some such process as the Pauly system. These tiles can be made at or reasonably near the site of the building. They do not, therefore, have to be shipped from a distantly located factory, with the expensive item for breakage. Being of the same material, they have the same coefficient of expansion by heat as the reinforced concrete ribs, and therefore crack less. Concrete tiles made by the Pauly process are accurate in shape and size, as there is no baking or consequent shrinking. They are so accurate in size that not only can they be laid cheaper than can any other tile, but they also require less plastering than tile

made of any other kind of material. Furthermore, they have greater compressive strength per square inch than the clay tile that Mr. Bevier recommends.

Hollow blocks made of cement can be furnished for much less money than of baked clay. They are little chipped and broken, as they can be teamed from a local factory instead of being shaken and shunted by railroad delivery, consequently the loss from breakage is less. Furthermore, the mason is enabled to lay them much more accurately, and more quickly because of their greater accuracy.

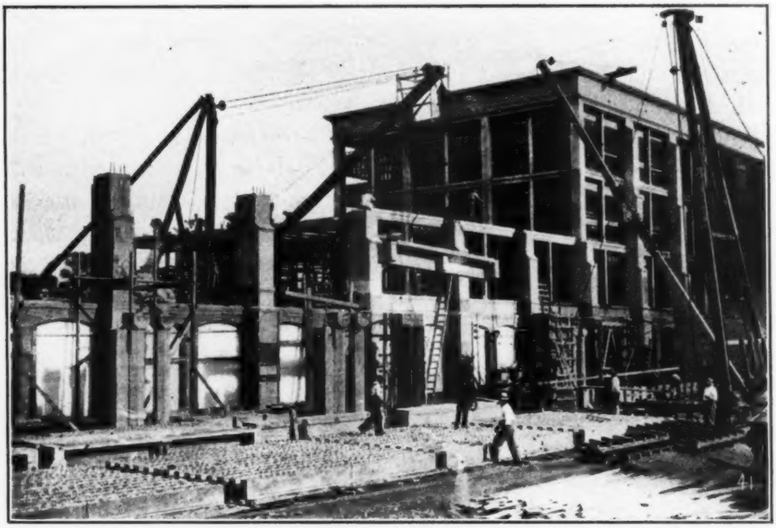


Fig. 34 United Shoe Machinery Company Concrete Building in Process of Construction

For places where hollow tiles are desirable, such as interior non-bearing partitions, those made of cement and the best quality of coarse sand or grit are more economical and more desirable from every standpoint. Hollow blocks made of cement and sand or grit are especially preferable where end construction is required. They are so nearly alike in size that less skilled workmen experience no difficulty in making the ends of the sides and partitions of the blocks rest accurately against the ends of the adjoining blocks, a comparatively difficult result to obtain in unevenly shrunk baked terra cotta, as any one knows who has actually laid it.

"That concrete walls can be poured in metal molds with sufficient accuracy to permit painting and wall papering without plastering or smoothing is another dream of the enthusiast which has not come to pass," to quote Mr. Bevier. It is only necessary to refer again to houses built by Morrill at Washington, D. C., and to call attention to the Times Square branch of the post-office on West 39th Street, New York, and to the office of Yale and Towne at Stamford, Conn. Many more illustrations of painting directly upon the concrete cast in wooden molds can be cited.

Fig. 35 Casting Separate Members for United Shoe Machinery Company Building

In reply to Mr. Main, the writer has as additional evidence from a mill engineer in Mr. Main's office, Boston, a large cotton mill recently constructed for him of concrete at a price within 10 per cent of the cost of mill construction. The results in this particular case came first from designing the building in mill construction and then asking the concrete contractor to duplicate it in concrete. It would be interesting to know what the result would have been if the building had first been designed in concrete, particularly as to the most economical spacing of structural members for concrete, and then built in mill construction.

Taking Mr. Main's statement that in the textile mills the value of

the building is not more than one quarter of the total value of the property, and his statement that concrete buildings cost even 25 per cent more, would it not be advisable to have legislation or a special tax on wood that by degrees would overcome this difference. There are also many by-products of loss to the country to offset the additional cost, if any, in the first cost of the buildings, such for example, as denuding our forests.

We must agree with Mr. Main that cotton and many other kinds of buildings should have complete sprinkler systems for the protection of their contents. His experience has been very great, many of the best textile and other mills in this country having been de-

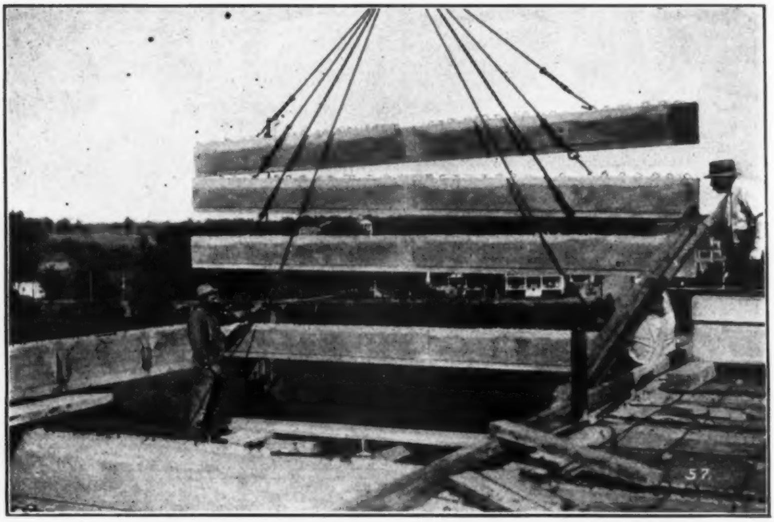


Fig. 36 Swinging Members into Position at United Shoe Machinery Company Building

signed by him, but if he will visit the buildings now in process of erection for the United Shoe Machinery Company, at Beverly, Mass., he will see an indication of an entirely new type of concrete building construction that is coming.

This building, which can be built under factory conditions on either wet, cold or fair days, is shown in Fig. 34. Much of it can be cast while the cellar is being excavated. This type of construction is particularly adapted to the central mixing plant where the separately molded units can be cast, consolidated by power ramming and allowed to season and dry out long before being used (Fig. 35).

The speed with which a building of this type has been and can be built is limited only by the speed with which the pieces can be swung into place by a derrick (**Fig. 36**). The steel or wood or concrete windows can be set by the same derrick at a less expense than they can be set later in the old fashioned way. The fine steel windows of the Kahn Company and the Fenestra Company cost little, if any, more than wood by the time they are set, when handled by the same appliances that set the separately cast concrete sections. A building comparatively dried out at the time of completion is the result.

There are other advantages not so obvious. It is made in a manner that permits the output of a larger percentage of workmen to be measured separately than does any other type of building.

The author believes that many greater economies will be made in future in buildings of every kind by the application of Fred. W. Taylor's laws of scientific management because the units are made on the ground under factory conditions and the output of each individual therefore can be measured separately. The method of building by means of separately cast members, while primarily for the purpose of making quick, dry, economical and substantial construction, adapts itself particularly well to the operation of the principles of scientific management.

The era of concrete is here. It may never entirely supersede other forms of building construction, but it will always be used more or less with other forms of building materials. It must be supplemented by other materials that will assist to make the buildings fire resisting. As a building material, properly made concrete is the best fire resistant and retardant yet discovered. To this almost all unprejudiced experts in building design and construction now agree, and the time is not far distant when the verdict will be unanimous. In the meantime, everybody can encourage the disuse of wood in building construction and thus eliminate our great fire havoc.

THE ROTARY KILN

By Ellis Soper, Published in The Journal for October 1910

ABSTRACT OF PAPER

The paper gives a brief history of the development of the rotary kiln and commercially successful applications of it. A drawing is shown of a typical installation of an 8 ft. by 125 ft. kiln for burning cement by the dry process. The temperature curves are for a 7 ft. by 100 ft. kiln and there are three curves showing chemical changes in kilns of various sizes. There is also a table of kiln sizes, outputs and fuel consumptions with relation of the diameter to the length and the actual results from lengthening a 6 ft. by 60 ft. kiln. The heat balance, calculation of mixture, etc., is given for an 8 ft. by 125 ft. kiln operating upon lime rock and shale, using the dry process; also curves showing stresses in shell due to the improper spacing of tires, the fallacy of supporting upon more than two tires and the proper spacing of tires when the weakening effect of heat is considered. A fuel consumption curve illustrating the law of pivotal points, size of kiln conditions remaining constant, and output in barrels per day at which the fuel consumption is a minimum are stated.

ADDITION TO DISCUSSION[1]

E. S. Fickes. The history of the development and utilization of the rotary kiln is one of the most remarkable instances in modern engineering of neglecting to develop and use a valuable apparatus for years after its invention.

In the British patent granted to Chas. W. Siemens in 1869, Mr. Siemens states that he is well aware of the previous employment of revolving cylindrical calcining apparatus and he, therefore, makes no claim of novelty for the rotary kiln described in his patent. His patent is of great interest, however, on account of the broad grasp of the possibilities of the rotary kiln displayed by Mr. Siemens in drawing it. In his application Mr. Siemens mentions the use of his invention for the "calcination of metallic ores and also the burning of such sub-

[1]Discussion of The Rotary Kiln, Ellis Soper, published in The Journal for April 1911.

stances as cement, lime or plaster of paris." His patent covers methods for utilizing the waste heat from the rotary kiln, the total calcination of metallic ores by bringing the heated ore into contact with heated atmospheric air alone, this being accomplished by advancing the point of combustion any desired distance into the rotating kiln, the introduction of jets of steam among the heated and partially reduced ores to produce further chemical reactions, the introduction of pulverized or liquid fuel into the kiln by means of a steam or air jet, the combination with the rotary kiln of a condensing chamber for the saving and utilization of sulphurous and other useful gases, the combining of such calcining apparatus with a smelting furnace so that the heat in the freshly calcined ore could be utilized in the smelting furnace, and the construction of the rotary kiln with a closed water-jacketed receiving chamber for the purpose of cooling pulverulent calcined materials without oxidation. It would be of interest to know something about the rotary calcining apparatus which was in use prior to 1869 when the Siemens' patent was granted, also to what extent the rotary kiln was developed and utilized under the Siemens' patents.

In 1885 patents were granted to Ransome for a combination of a rotary kiln and gas producer and some commercially unsuccessful attempts were made in England to use the apparatus to burn portland cement under this patent. As stated by Mr. Soper, a year later the real development of the rotary kiln for making cement began in this country. While producer gas was used successfully as fuel in one or two instances, it was soon found that it could not compete with powdered coal for burning cement clinker. For drying or calcining many materials, however, the use of powdered coal is very objectionable or even entirely out of the question on account of the ash from the coal mixing with the material under treatment and in such cases liquid or gaseous fuel must be used. Natural gas or oil is to be preferred, but their cost often necessitates the use of producer gas.

While the rotary kiln within the last ten years has come into general use in the cement industry, its use for drying, roasting and calcining other materials is by no means so great as is warranted by its utility and the economies which can be effected by its use. Although the Siemens' patent mentions the burning of lime, and Henry Mathey was granted United States patents in 1885 for a process for making lime by crushing the stone to a suitable fineness and then burning it in a rotary kiln, the writer does not know of lime being successfully burned on a commercial scale in a rotary kiln in the United States until 1893 when it was so made by the California Portland Cement Company.

In 1905 or 1906 the New York Lime Company started to burn lime at Natural Bridge, N. Y., using a 100 ft. by 6 ft. rotary kiln fired by gas from a 10-ft. Morgan producer, and in 1907 both the Union Carbide Company and the Aluminum Ore Company built rotary kiln lime plants, the latter using 120-ft. kilns and having a capacity of from 200 to 300 tons of lime per day.

In 1902 the writer installed a 60 ft. by 5 ft. rotary kiln for drying and dehydrating bauxite, using producer gas as fuel. Since then he has built additional drying plants of this type and several similar plants for chemical industries, one of which consists of four 120 ft. by 7 ft. rotary kilns employing a temperature of 2000 deg. fahr. for dehydrating salts containing chemically combined water. The fuel used is producer gas and an elaborate separating and gas washing apparatus was installed in connection with this plant to save the valuable dust carried off by the waste gases from the kilns. In none of these plants could powdered coal be used on account of the ash resulting from its combustion.

The writer quite agrees with Mr. Soper regarding the use of the rotary kiln as a direct heat dryer and has used it in preference to patent dryers whenever the output and character of the material to be dried would warrant its use. Used as a dryer, the simple and strong construction of a good rotary kiln insures a large output with low maintenance cost and few interruptions, which is far from being true of many other kinds of dryers. The limited use of the rotary kiln as a dryer is only less remarkable than the slow progress it has made in chemical and metallurgical plants where it can often be used in place of much more expensive and less efficient apparatus.

GAS POWER SECTION

PRELIMINARY REPORT OF LITERATURE COMMITTEE

(VI)

ARTICLES IN PERIODICALS

AERO AND MOTOR BOAT SHOW, THE. *The Engineer (London), March 31, 1911.* 2½ pp., 7 figs. *Cabcf.*

A comment upon the motor boat, hydroplane and aeroplane engines exhibited at Olympia, emphasizing various qualifications and suggested requirements.

AEROPLANE MOTOR, THE WOSELEY EIGHT-CYLINDER. *London Engineering, March 24, 1911.* 1½ pp., 3 figs. *bc.*

Details of construction of 60-h.p. and 120-h.p. motors.

CALORIMETER, THE DOHERTY GAS. *The Iron Age, April 13, 1911.* 1½ pp. 2 figs. *bc.*

A description of a calorimeter in which the calorific value of any combustible gas can be measured with little or no calculation on the part of the operator.

COAL, AN ENGINE THAT GENERATES ITS OWN GAS FROM. *Power, March 14, 1911.* 1 p., 3 figs.

A gas generator and engine combined for which the inventor claims a fuel consumption of 0.4 lb. coal per b.h.p-hr.

COMPRESSION. *Gas Power, March 1911.* 1 p.

How to determine the necessary amount and how it often affects the engine.

CROSSHEAD STOP, DOES THE, William T. Kingsley. *Power, February 7, 1911.* ½ p., 1 curve.

Proved that it does not.

Opinions expressed are those of the reviewer, not of the Society. Articles are classified as· *a* comparative; *b* descriptive; *c* experimental; *d* historical; *e* mathematical; *f* practical. A rating is occasionally given by the reviewer, as *A, B, C.* The first installment was given in The Journal for May 1910.

Engine in the Agricultural Field at Home and Abroad, The Gasoline, George Cormac, Jr. *Gas Power, March 1911.* 5 pp.

Economy.

Engines for Navy Launches, Internal-Combustion, Lieut. W. G. Diman. *American Society of Naval Engineers, August 1910.*

Report of trials at Norfolk navy yard of 2 and 4-cycle gasolene engines. Also giving Lloyds rules for internal-combustion engines.

Engines for Submarines, Oil. *The Engineer (London) March, 24, 1911.* 2½ pp., 7 figs. *bf.*

Descriptive of the Koerting Bros. single-acting, 2-cycle type, valveless oil motors, built for the Norwegian submarine Kobben.

Engines, Large Two-Cycle. *The Engineer (London), March 3, 1911.* 1 p., 4 figs. *Cabf.*

Extract of paper by A. E. L. Chorlton before the Manchester Association of Engineers.

Engines of the Two-Cycle Type, Large Gas, A. E. L. Chorlton. *London Engineering, March 10, 1911.* 8½ pp., 16 figs., 2 tables. *bdf.*

Also *March 24, 1911.* 7 pp., 7 figs, 2 tables, 7 curves. *bc.*

Paper before Manchester Association of Engineers, February 25, 1911.

Fire Service Water Works System of Winnipeg, Lieut. Col. N. H. Ruttan. *Proceedings American Water Works Association, 1911.* 15 pp., 7 figs., 1 map.

General description of plant and test of station using producer gas, emergency, connection to city gas mains.

Gasheizung für Kirchen, Die Bedeutung, P. Spaleck. *Journal für Gasbeleuchtung und Wasserversorgung, February 11, 1911.* 4 pp. ,2 figs.

Also *February 25, 1911.* 2½ pp., 5 figs., 1 curve. *B.*

The importance of gas heating for churches and large halls.

Generator mit Gewinnung des Dampfer durch Verbrennung des Generator gases ohne Dampf Ressel System-Strache, A. Breising. *Dinglers Polytechnisches Journal, March 4, 1911.* 1½ pp., 1 fig., 1 table. *Abf.*

Water gas generator in which the necessary steam is developed in a pipe system heated by the gases from the generator omitting a separate steam boiler.

Ignition, Gas Engine, E. Q. Williams. *Gas Power, February 1911.* 2 pp.

Ignition on the Efficiency and Output of Internal Combustion Engines. The Influence of Multipoint, Otto Heines. *The Gas Engine, April 1911.* 4 pp. 1 fig., 1 table, 8 curves.

Paper before the Society of Automobile Engineers. Shows the loss in efficiency due to the ignition lead required to compensate for the time of flame propagation and how this may be remedied by two ignition points. Tests with single and two point ignition with curves showing effect on horsepower developed, reduction of lead, and the power developed at various degrees of advance.

Heat to Turbine, Gas Engine Waste, E. D. Dreyfus. *Power, April 11, 1911.* 7¼ pp., 2 figs., 10 curves. *bc.*

A description of a composite steam and gas plant using waste heat from gas engines to generate steam for low-pressure turbines.

Indicator, Reducing Motion for Gas Engine, R. G. Brown. *Power, February 7, 1911.* 1 p., 2 figs., 1 curve.

Meter, The Thomas. *The Iron Age, March 16, 1911.* 3 pp., 6 figs., 1 curve. *bf.* Electrically operated device for measuring gases of all kinds.

Motor Boats, Two. *The Engineer (London), March 31, 1911.* 1¼ pp., 5 figs. *Abf.*

Describes fireboat Gamma of the London Fire Brigade and the motor driven oil barge Rocklight of the British Petroleum Company. The fireboat Gamma is 66 ft. 6 in. long by 11 ft. 6 in. beam, driven by two Thornycroft *D*4 paraffin motors which develop 80 h.p. at 700 r.p.m. These motors are also used for driving the high-pressure pumps. The oil barge Rocklight is 100 ft. 6 in. long by 17 ft. beam. Motion power consists of a six-cylinder Thornycroft motor developing 70 h.p. at 750 r.p.m.

Motors, Marine Diesel. *International Marine Engineering, April 1911.* ½ pp.

Describes paper before German Naval Architects by Director Samberlich of Osterholz-Scharmbeck, Bremen.

Produccion de Gas Hidrocarburo al Vacio. *El Comercio, January 1911.* ½ p. *ab.*

A new system of carburetting in vacua.

Producer, Elementary Lectures on the Gas, C. P. Poole. *Power, March 14, 1911.* 3¼ pp., 3 figs. 3 tables. *bc.*

Usefulness of the economizer, effect of the vaporizer, vaporizing in the ash pit. Calculations for the saving effected by preheating the air by the outgoing gases.

Producer-Gas Engine Plants, Gas, W. O. Webber. *The Iron Age, March 16 1911.* 2¼ pp., 3 tables, 5 curves. *abf.*

Details of installation and maintenance cost.

Producer Plant, A Composite Pressure and Suction. *Power, April 4, 1911.* 1¼ pp., 5 figs. *b.*

Describes a New England manufacturing plant equipped with three generators and two combination type scrubbers. An unusual feature of this plant is the use of both suction and pressure to create draft through the generator

Pumping Stations on the Manchester Ship Canal. *The Engineer, March 24, 1911.* ½ p., 3 figs., 1 table. *bf.*

Describes oil pumping station of 22,000 gal. per min. Driven by 200 h.p. Mirrless-Diesel engine, coupled to a 36-in. Drysdale centrifugal pump.

Ratios Gas Engine Compression and Expansion, C. P. Poole. *Power, March 21, 1911.* 2 pp., 2 figs., 3 tables. *e.*

Starting and Reversing of Marine Gas Engines, Reliable, E. N. Percy. *Gas Review, February 1911.*

Torfmoore unter Berücksichtigung der Krafterzeugung, der Gewinnung der Nebenerzeugnisse und der Beeinflussung unserers Volkswohlstandes. *Zeitschrift des Vereins deutscher Ingenieure, March 11, 1911.* 5 pp., 1 fig. *bdef.*

On the utilization of turf with regard to power production, the recovery of the by-product and its influence for public good.

Turbines, Gas. *The Gas Engine, April 1911.* 4 pp., 1 table, *Aacd.*

Extract of paper by H. Grinsted, before Coventry Branch of Institute of Automobile Engineers. Discusses the thermo-dynamic side of the question and points out the desirable qualities which may be obtained when the gas turbine has been perfected. Reviews the practical work done in the gas turbine field and compares the results with gas engines.

Verbrennungsmaschinen, Die Wohl des Zundzeitpunktes bei Fahrzeug, A. Heller. *Zeitschrift des Vereins deutscher Ingenieure, February 25, 1911.* 2 p., 3 figs., 4 curves.

An article on ignition.

GENERAL NOTES

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

The President and Board of Directors of the American Institute of Electrical Engineers extend a cordial invitation to the members and ladies of The American Society of Mechanical Engineers to be present at their Annual Meeting, held on Tuesday evening, May 16, 1911, in the Auditorium of the Engineering Societies Building, at which there will be the formal presentation of the Edison Medal to Frank J. Sprague. There will also be four addresses by prominent speakers on appropriate topics.

THE CIVIC FORUM

An address on The New Conception of Business and Industrial Efficiency was given by Frederick W. Taylor, Past-President Am.Soc.M.E., in Carnegie Hall, New York, April 28, before The Civic Forum, an educational society for the discussion of public questions. Brief addresses were also made by John Golden on the Attitude of Organized Labor towards Scientific Management and by Frank B. Gilbreth, Mem.Am.Soc.M.E., on the Practical Application of Scientific Management.

AMERICAN INSTITUTE OF MINING ENGINEERS

A meeting of the American Institute of Mining Engineers will be held June 6-10, 1911, in the Pennsylvania anthracite region, where the institute was organized at the Wilkes-Barre meeting of May 1871. Headquarters will be at the Glen Summit Springs Hotel, Glen Summit Springs, Pa. Visits are planned to the Hazard Wire Rope Works and to the new concrete and iron breaker of the Lehigh Valley Coal Company; to Lehigh University to inspect the John Fritz Engineering Laboratory and the E. B. Coxe Mining Laboratory; to the Bethlehem Steel Works; the anthracite coal-storage plants of the Lehigh Valley Coal Company, and the briquetting-plant of the Lehigh Coal and Navigation Company; the Summit Hill mine-fire, returning by way of the switchback to Mauch Chunk, and thence to Glen Summit; and to the underground workings of various coal mines. Among the papers announced for presentation are the following: A Drafting Table for Tracing through Opaque Paper, A. T. Schwennesen; Proposed Code of Rules for Installation and Use of Electricity in Mines, S.A. Taylor; The Application of the Equation of the Straight Line to the Reduction of Triangulation Readings, L. D. Moore; The Fuel-Efficiency of the Iron Blast Furnace, J. J. Porter; Some Radical Improvements in the Practice of Concentrating Minerals by the Use of Wet Tables, S. A. Krom; Electrical Practice in

Mines, B. McCollum; The Bituminous Coal Industry, S. K. Smith; History and Geology of Ancient Gold-Fields in Turkey, L. Dominian; Tunnel Driving in the Alps, W. L. Saunders; The Storage of Anthracite Coal, R. V. Norris, Mem. Am. Soc.M.E.; The Anthracite Arbitration Board, S. D. Warriner, Mem.Am.Soc. M.E.; Briquetting-Plant of the Lehigh Coal and Navigation Company, C. Dorrance, Jr.

AMERICAN ACADEMY OF POLITICAL AND SOCIAL SCIENCE

The annual meeting of the American Academy of Political and Social Science was held April 7 and 8, 1911, at Witherspoon Hall, Philadelphia, Pa. The five sessions of this meeting were devoted to the discussions of such questions as Industrial Accidents and Their Prevention, Employers' Liability and Workmen's Compensation. The meeting took the form of a great national conference to consider and discuss the experience of the different sections of the country and to reach some conclusion as to the measures which should be adopted in order to harmonize the industrial interests of the country with the legitimate demands of the laboring classes. The Society was represented by James Christie, J. Sellers Bancroft, John N. Birkinbine, Geo. W. Melville and Arthur C. Jackson. James M. Dodge, Past-President of the Society, was a member of the committee to arrange a special exhibit of safety devices. A paper on Work of the United States Government in the Prevention of Accidents was read by J. A. Holmes, Mem. Am. Soc. M. E., as were many others dealing with the various phases of the subject.

NATIONAL ASSOCIATION OF COTTON MANUFACTURERS

The annual meeting of the National Association of Cotton Manufacturers was held at the Massachusetts Institute of Technology, Boston, April 12 and 13, 1911. One of the first items of business was the presentation of the association medal to Chas. T. Main, Mem.Am.Soc.M.E., in recognition of the merits of his paper on Choice of Power for Textile Mills and his contributions to mill engineering. President Maclaurin of the Massachusetts Institute of Technology delivered an address and papers were read on the following subjects: Arbitration on Cancellation of Orders, Coöperation between Bureaus of the Federal Government and Textile Manufacturers; Efficient Buying of Raw Material; How the Cotton Industry has Safeguarded its Employees; Law of Moisture in Cotton; Power from Producer Gas, Production of Cotton in the Honolulu Islands, Renaissance of the Waterfall, Risks of Cotton Manufacturing, Standardizing the Artificial Illumination of Cotton Mills, Textile Education from a Manufacturing Standpoint, Transmission of Power by Ropes and Uniform Contracts. Col. E. D. Meier represented the Society at the meeting and spoke briefly of the relation between the mechanical engineer and the cotton industry. One of the special features of this convention was the demonstration on the Massachusetts Institute of Technology lawn of a cotton-picking machine.

WATER POWER CONSERVATION CONGRESS

A public conference on waterpower conservation was called on April 8, 1911, in the Engineering Societies Building by the transmission section of the National Electric Light Association. In order to give the best opportunity for a general interchange of ideas the conference was divided into two sessions, the papers being presented in the afternoon, when the general status of present conservation policies were reviewed, and the entire evening session being devoted to a discussion of conservation problems. The attendance was large and a number of men closely identified with water power development throughout the United States took part in the open discussions. Secretary of the Interior Fisher made a brief address in which he stated that the government had no set legislative policy concerning conservation, but that the aim had been, rather to maintain the present status until a suitable policy could be decided upon. It was his opinion that the State and the Federal government has no conflicting interests in such legislations. Papers were read by S. Z. Mitchell, J. R. McKee, Richard Lamb, H. E. Cutter, J. G. White and Mr. Frothingham. Discussion by C. F. Scott, R. D. Mershon, Mem. Am .Soc. M. E., F. J. Sprague, P. H. Thomas, D. B. Rushmore, Mem.Am.Soc.M.E., and John Bogart brought out interesting phases of the conservation question.

BROOKLYN ENGINEERS' CLUB

An exhibit of engineering materials, models and plans of engineering machinery, together with photographs and drawings of important engineering structures was held at the club-house, 117 Remsen Street, April 17–22, 1911. The exhibit included a variety of subjects from a model of a refuse destructor plant to one showing the complete working of a modern fire alarm system. Descriptive and explanatory talks were given in which the workings and uses of some of the various exhibits were explained. The engineers of the Public Service Commission showed the plans of the new Fourth Avenue Subway, now under construction in Brooklyn, together with charts made and the methods employed.

TECHNOLOGY CONGRESS AT BOSTON

The fiftieth anniversary of the founding of the Massachusetts Institute of Technology was commemorated at Boston on April 10 and 11, 1911, by a Congress of Technology, which was attended by a large number of scientists and engineers from all parts of the country and at whose sessions about 60 papers were presented covering a wide range of industrial, financial, economic and engineering topics. Through a broad treatment of topics the various papers did much to summarize the latest progress in the fields of sanitation, railway administration, efficiency management, industrial education, conservation, metallography, research, chemistry, architecture, mechanical and electrical engineering; but beyond this the needs of the future were frequently indicated in specialized departments, and the direct connection between science and com-

mercial progress was repeatedly emphasized. There were four paper contributed by members of the Society, namely, The Continuous Cooling of Circulating Water Used in Condensing Steam, E. F. Miller; Scientific Industrial Operation, Tracy Lyon; Thirty Years' Work in Boiler Testing, G. H. Barrus; The Prevention and Control of Fires through Scientific Methods, E. V. French. The Society was officially represented at the Congress by its President, Col. E. D. Meier.

NATIONAL METAL TRADES ASSOCIATION

The annual convention of the National Metal Trades Association was held at the Hotel Astor, New York, April 12 and 13, 1911. William Butterworth chairman of the Committee on Employers' Liability Insurance, reported on that subject and R. C. Bolling, M. M. Dawson, J. A. Macdonnell and H. V. Mercer discussed it.

ECONOMIC CLUB

At the annual dinner of the Economic Club at the Hotel Astor, New York, the subject of scientific management of industrial plants was discussed. James O. Fagan and James Duncan represented the labor point of view. They expressed deep distrust of the new ideas, and said that to the employee the principle of settling his work on a scientific basis means ultimately the exaction of a greater amount of work by the employed for the same rate of pay as at present. Harrington Emerson, Mem. Am. Soc. M. E., L. D. Brandeis, H. R. Towne and Frank B. Gilbreth, Mem. Am. Soc. M. E., were the set speakers for efficiency management and testified that they have adopted it in their own works and found it to work not only to their advantage, but to the advantage of the employees as well.

PERSONALS

L. B. Alexander, formerly assistant chief of department of the Bosch Magneto Co., New York, has been appointed general sales manager of the same company.

W. H. Baltzell, recently chief engineer of the Donora Steel Works, Donora, Pa., has accepted a similar position with the Pittsburg Crucible Steel Co., Pittsburg, Pa.

John H. Barker has been appointed manager of the New York office of the Diehl Manufacturing Co. He was formerly salesman of the special apparatus department of the same company.

George G. Bennett, formerly connected with the engineering department of the American Thread Co., Holyoke, Mass., has become efficiency engineer for the Ludlow Manufacturing Associates, Ludlow, Mass.

William P. Bixby has accepted a position with the Union Wadding Co., Pawtucket, R. I. He was until recently identified with the mechanical department of the Erie Railroad Co., New York.

Jos. K. Blum has accepted a position with the Coplay Cement Manufacturing Co., New York, as mechanical engineer.

Walter E. Brown, formerly assistant engineer and superintendent of the Penn Motor Car Co., Pittsburg, Pa., has become affiliated with the Middleby Auto Co., Reading, Pa., in the capacity of superintendent.

Wm. Clinton Brown, consulting engineer, formerly located at Montreal, Canada, has been appointed chief engineer of the Humphrey Gas Pump Co., Syracuse, N. Y.

A. O. Carpenter has become associated with the designing department of Ingersoll-Rand Co., Painted Post, N. Y. Mr. Carpenter was formerly identified with the Chicago Pneumatic Tool Co., as chief draftsman of their Franklin, Pa. plant.

Robert L. Cork, formerly associated with the Western Gas Construction Co., Fort Wayne, Ind., has been appointed chief engineer of the Almont Manufacturing Co., Almont, Mich.

M. Craighead has become connected with the sales department of the Link-Belt Co., representing them in Boston. He was formerly associated with the Lehigh Coal & Navigation Co., Philadelphia, Pa.

Fred H. Daniels, chief engineer of the American Steel & Wire Co. has been made chairman of the Shop Committee of the Board of Trustees of the Worcester Polytechnic Institute, Worcester, Mass.

John Fallon has resigned the position of assistant engineer with the Tennessee Copper Co., Copperhill, Tenn., to become associated with Percival Robert Moses, consulting engineer, New York.

Hardy S. Ferguson, formerly chief engineer of the Great Northern Paper Co., Millinocket, Me., has opened an office in New York, as a consulting engineer.

Geo. F. Gast has become connected with the construction department of the Minnesota & Ontario Power Co., International Falls, Minn. Mr. Gast was until recently chief draftsman and construction engineer with Walter Kidde, New York.

Waldo G. Gernandt has accepted a position with the Packard Motor Car Co., Detroit, Mich., as designer in the carriage chassis department. He was formerly factory engineer of the Rapid Motor Vehicle Co., Pontiac, Mich.

E. L. Hill, recently appointed assistant superintendent of the American Steel and Wire Co.'s electrical cable works in Worcester, Mass., has been made superintendent of the plant.

Reuben Hill, formerly identified with the Hudson Motor Car Co., Detroit, Mich., has assumed the duties of superintendent of the Detroit Lubricator Co., Detroit, Mich.

A. L. Kenyon has been appointed chief of construction for the Georgia Power Co. at Tallulah Falls, Ga. He was formerly identified with the Empesas Electricas Associadas at Lima, Peru, in the capacity of chief engineer.

A. G. Kessler has become connected with the Ball Engine Co., Erie, Pa. He was recently associated with the engineering department of R. G. Peter's Manufacturing Co., Grand Rapids, Mich.

W. S. Lee, chief engineer of the Southern Power Co., Rock Hill, S. C., has been elected vice-president and chief engineer of the Greenville, Spartanburg & Anderson Railway, Greenville, S. C.

L. B. Lent has severed his connections with the Riverside Engine Co., New York, to assume the duties of chief engineer of the New York Blaugas Co., with headquarters at Brewster, N. Y.

John P. McJilton, formerly associated with the American Locomotive Co., Schenectady, N. Y., as draftsman of the superheater department, has assumed the position of draftsman for the Locomotive Superheater Co., New York.

J. H. Maysilles has resigned the position of general foreman of the electric locomotive and truck department of the American Locomotive Co., Schenectady, N. Y., and has accepted the position of superintendent of the Davenport Locomotive Works, Davenport, Ia.

C. J. Morrison has become identified with the department of effective organization of Suffern & Son, New York. This department, under the direction of Mr. Morrison, has been organized to aid in securing the most effective organizations and the most efficient methods in manufacture and business.

J. N. Mowery, formerly connected with the L. V. R. R., Auburn, N. Y., as master mechanic, has accepted a similar position with the N. Y. N. H. & H. R. R., Waterbury, Conn.

Stephen Quinn, formerly chief engineer of the Iola Portland Cement Co., Iola, Kan., has accepted a similar position with the Knickerbocker Portland Cement Co., Hudson, N. Y.

Charles R. Richards, dean of the college of engineering of the University of Nebraska has been appointed professor of mechanical engineering, in charge of the department at the University of Illinois. The appointment takes effect September 1, 1911.

John D. Riggs, has accepted a position as chief draftsman with the Oliver Chilled Plow Works, South Bend, Ind. He was formerly connected with the P. M. & Co., Chicago, Ill., as tool designer.

John W. Sheperdson formerly steam engineer of the Cambria Steel Co., Johnstown, Pa., has been promoted to assistant superintendent of the gautier department of the same company.

Henry D. Watson, for a number of years assistant manager of the Westinghouse Machine Co., New York, has resigned his position to become the Eastern sales manager of the Saurer Motor Co. with offices in New York.

H. J. White has resigned the position of mechanical expert with the Lanson Monotype Machine Co., of Philadelphia, Pa., to assume the duties of works manager and mechanical engineer of the Krantz Manufacturing Co., Brooklyn, N. Y.

William L. Wilson has left the employ of the Aluminum Co. of America, Chicago, Ill., as salesman, to accept the position of vice-president of The Electric Installation Co., Baltimore, Md.

Oliver B. Zimmerman has accepted a position with E. Burner & Co., South Bend, Ind. He was formerly identified with M. Rumely Co., La Porte, Ind.

ACCESSIONS TO THE LIBRARY

This list includes only accessions to the library of this Society, included in the Engineering Library. Lists of accessions to the libraries of the A. I. E. E. and A. I. M. E. can be secured on request from Calvin W. Rice, Secretary, Am. Soc. M. E.

L'AEROPHILE. Years 1–7; 8, nos. 7, 9, 11; 9, nos. 1–4, 6, 8–12; 10, nos. 1–11; 11; 12, nos. 2–3, 5–12; 13; 14, nos. 1–6, 9, 11, 12; 15, nos. 2–4, 6–8. *Paris, 1893–1907.*

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DRYING MACHINERY AND PRACTICE. By T. G. Marlow. *New York, Van Nostrand Co., 1910.*

ELECTRIC WIRING, FITTINGS, SWITCHES, AND LAMPS. By W. P. Maycock. ed. 4. *London, New York, 1911.*

ELEMENTS OF DESCRIPTIVE GEOMETRY. By A. E. Church and G. M. Bartlett. *New York, American Book Co., 1911.*

FULLER-LEHIGH PULVERIZER MILL. Gift of the Lehigh Car, Wheel and Axle Works.

LE GENIE CIVIL. Vols. 1–23, 1880–1893. *Paris, 1880–1893.*

HARDWOOD FINISHER. By C. Godfrey. *New York, Industrial Publication Co., 1908.*

HARVARD UNIVERSITY. Report of the President and Tresurer 1909–1910. *Cambridge, 1911.* Gift of the university.

HYDRAULIC PROPERTIES OF REGROUND CEMENT MORTARS. By H. S. Spackman and R. W. Lesley. Gift of the Lehigh Car, Wheel and Axle Works.

HYGIENE IN HEATING. By Konrad Meier. Reprinted from Heating and Ventilating Magazine, January 1911. Gift of the author.

ICE AND REFRIGERATION BLUE BOOK. 1909. *Chicago, New York, Nickerson & Collins Co.*

IGNITION HAND BOOK. By H. R. Van Deventer. *1911.* Gift of Sumter Telephone Mfg. Co.

INDUSTRIAL PLANTS, THEIR ARRANGEMENTS AND CONSTRUCTION. By Chas. Day. *New York Engineering Magazine. 1911.*

LOUISIANA PLANTER, THE. Vol. 38, nos. 2, 23, 26; Vol. 39, nos. 1–10; Vol. 40, no. 14; Vol. 41, no. 24; Vol. 42, no. 5. *New Orleans, 1907–1909.* Gift of the Louisiana Planter.

LOGARITHMIC TRIGONOMETRICAL TABLES, WITH EIGHT DECIMAL PLACES. By J. Bauschinger and J. Peters. Vol. 1. *Leipzig, 1910.*

NATIONAL COMMERCIAL GAS ASSOCIATION. Proceedings of the 6th annual meeting, 1910. *1910.* Gift of the association.

NEW JERSEY BOARD OF PUBLIC UTILITY COMMISSIONERS. 1st Annual Report. 1910. *Trenton, 1911.* Gift of the board.

NEW YORK CITY BOARD OF WATER SUPPLY. 4th Annual Report. 1909. *New York, 1909.* Gift of the board.

NEW YORK CITY BOARD OF WATER SUPPLY. Annual Report. 1906. *New York, 1906.* Gift of the board.

——Specifications and contracts. Nos. 3–4, 9–10, 12, 15, 20, 24, 30–31, 39, 42–44, 47–48, 53–55, 59, 60, 68, 73. *1907–1910.*

——Contract drawings to Nos. 3–4, 9, 10, 12, 15, 20, 24, 30–31, 42–44, 47, 53–55, 59, 60, 68. Gift of the board.

NEW YORK STATE WATER SUPPLY COMMISSION. 6th Annual Report. 1910. *Albany, 1911.* Gift of the commission.

PACIFIC COAST GAS ASSOCIATION. Proceedings. Vol. 8. 1909–1910. Gift of the association.

PITTSBURGH TRANSPORTATION PROBLEM, REPORT ON. By B. J. Arnold, December 1910. *Pittsburgh, 1910.* Gift of the author.

PRACTICAL GAS ENGINEER. By E. W. Longanecker, ed. 8. *1910.*

PRINCETON UNIVERSITY. Catalogue 1910–1911. *Princeton, 1910.* Gift of the university.

REMARKS ON MR. JOHN FITCH'S REPLY TO MR. JAMES RUMSEY'S PAMPHLET. By Joseph Barnes. *Philadelphia, 1788.*

STANDARD METHODS OF TESTING AND SPECIFICATIONS FOR CEMENT. *1909.* Gift of the Association of American Portland Cement Manufacturers.

SYRACUSE UNIVERSITY. April 1911. (University Number.) *Syracuse, 1911.* Gift of the university.

TEMPERATURE ENTROPHY DIAGRAM. By C. W. Berry, ed. 3. *New York, J. Wiley & Sons, 1911.*

TEXT BOOK OF THE ELEMENTS OF MACHINE WORK. By R. H. Smith. *Boston, Industrial Education Book Co., 1910.*

TEXT BOOK OF THE PRINCIPLES OF MACHINE WORK. By R. H. Smith. *Boston Industrial Education Book Co., 1910.* (Gift of the authors.)

TREATISE ON THE APPLICATION OF STEAM. By James Rumsey. *Philadelphia, 1788.*

U. S. INTERSTATE COMMERCE COMMISSION. 3d Annual Report of the Block Signal and Train Control Board, 1910. *Washington, 1911.* Gift of the commission.

UNIVERSITY OF OKLAHOMA. Research Bulletin No. 4, 1910. *Norman, 1910.* Gift of the university.

UNIVERSITY OF PENNSYLVANIA. Proceedings of "University Day," February 22, 1911. *Philadelphia, 1911.* Gift of the university.

WASHINGTON STATE INSPECTOR OF COAL MINES. Report, 1910. *Olympia, 1911.* Gift of Washington Coal Mine Inspector.

WESTERN RAILWAY CLUB. Official Proceedings. Feb., May, Sept. 1889; April, Nov. 1890; Oct-Dec. 1893; Jan-May, Sept. 1894; Jan-May 1896. Jan-Feb., Apr-May, 1897. *Chicago, 1889-1897.* Gift of the club.

EXCHANGES

AMERICAN GAS INSTITUTE. Proceedings, Vol. 5, 1910. *New York, 1911.*

AMERICAN SOCIETY OF CIVIL ENGINEERS. Transactions. Vol. 71. 1911. *New York, 1911.*

SMITHSONIAN INSTITUTION. Annual Report. 1909. *Washington, 1910.*

SOCIETE INGENIEURS CIVILS DE FRANCE. Annuaire, 1911. *Paris, 1911.*

UNITED ENGINEERING SOCIETY

BUILDINGS OF REINFORCED CONCRETE. By Chas. Derleth, Jr. Paper before the 34th annual meeting of the Fire Underwriters Association of the Pacific, January 11-12, 1910. Gift of the author.

FÖRSLAG TILL EN SVEA KANAL. By C. C. Engström. 1-2. *Stockholm, 1908, 1910.* Gift of the author.

FOUNDATIONS FOR THE MUNICIPAL BUILDING, NEW YORK. By Maurice Deutsch. Reprinted from School of Mines Quarterly, Vol. 32, No. 1. Gift of the Foundation Company, New York.

MASSACHUSETTS STATE FORESTER. 7th Annual Report, 1910. *Boston, 1911.* Gift of Massachusetts State Forester.

METER CODE OF THE ASSOCIATION OF EDISON ILLUMINATING COMPANIES. 1910. *New York, 1910.* Gift of the association.

NEBRASKA STATE RAILWAY COMMISSION. 3d Annual Report. 1910. *Nebraska.* Gift of the commission.

PUBLISHERS' TRADE LIST ANNUAL. 1910. *New York, 1910.*

REFERENCE CATALOGUE OF CURRENT LITERATURE. Vols. 1-3, 1910. *London, New York, 1910.*

South Carolina Railroad Commission. 32d Annual Report. 1910. *Columbia, 1911.*

Standard Specifications for Structural Steel, etc. 1910. Gift of Carnegie Steel Company.

TRADE CATALOGUES

The Bristol Co., *Waterbury, Conn.* Bull. no. 127, Bristol's Class 3 recording thermometer for temperatures between 60 deg. and 800 deg. fahr., 39 pp.; Bull. no. 131, Bristol's recording voltmeters for direct and alternating current, 43 pp.

Cincinnati Gasket and Packing Co., *Cincinnati, O.* The latest gaskets 12 pp.

Davis-Bournonville Co., *New York.* Oxy-acetylene welding and cutting apparatus, 32 pp.; leaflets and cuts illustrating welds made, 50 pp.; Autogenous Welding, February 1911. A magazine devoted to welding and cutting, 15 pp.

Lewis M. Ellison, *Chicago, Ill.* Ellison power plant instruments, 32 pp.

Fiske & Co., *Boston, Mass.* Tapestry brick fire places of various designs, 35 pp.

General Electric Co., *Schenectady, N.Y.* Bull. no. 4787, wires and cables, 73 pp.; Bull. no.4806, electric fans and small power motors, 42 pp.;Index to Bulletins, February 1911, 8 pp.; Bull. no. 4791, feeder voltage regulators, 23 pp.; Bull. no. 4799, waterwheel driver alternators, 11 pp.; Bull. no. 4800, indirect current motors, type CVC, 22 pp.; Bull. no. 4811, drum controllers for individual service, 11 pp.; Bull. no. 4812, small direct-current generators, belted, type CVC, 10 pp.; Bull. no. 4813, type *F* form *P* oil break switches for pole line service, 3 pp.; Bull. no. 4817, G..E. 214 railway motor, 18 pp.

Goldschmidt Thermit Co., *New York.* Reactions, 1st Quarter, 1911, devoted to the science of aluminothermics, 20 pp.

Guarantee Construction Co., *New York.* Economic handling and storage of coal and ashes in power plants.

Harrington & King Refrigerating Co., *Chicago, Ill.* Blue prints of perforated articles made, 36 pp.; perforated metals, brass and tin plate, 8 pp.; standard diagonal slot screens, 16 pp.

Johns-Manville Co., *Cleveland, O.* J. M. Roofing Salesman, March 1911, devoted to advertising of roofing, 8 pp.; J. M. Packing Expert, March 1911, published in the interest of perfect packing, 4 pp.

Lehigh Clutch Co., *Catasauqua, Pa.* Friction clutches, 8 pp.

Thomson Electric Welding Co., *Lynn, Mass.* Electric welding machines, 32 pp.

Waterbury Co., *New York.* The simultaneous installation of seven high tension submarine cables, 16 pp.

EMPLOYMENT BULLETIN

The Society has always considered it a special obligation and pleasant duty to be the medium of securing better positions for its members. The Secretary gives this his personal attention and is most anxious to receive requests both for positions and for men available. Notices are not repeated except upon special request. Copy for notices in this Bulletin should be received before the 12th of the month. The list of men available is made up of members of the Society and these are on file, with the names of other good men not members of the Society, who are capable of filling responsible positions. Information will be sent upon application.

POSITIONS AVAILABLE

084 High class electrical engineer, age about 30, as office partner to consulting mechanical engineer with office in New York.

085 Good operating machine shop superintendent for factory in Springfield, Mass., manufacturing electric magnetos for automobile and gas engine ignition. Experience and ability to design to certain extent jigs, fixtures, templates, etc. Will be principally concerned in taking care of manufacturing end of business and in charge of actual manufacture. Location, Massachusetts.

086 Research engineer wanted. An old established well organized and successful company, manufacturing high class product, desires to secure the services of a practical man well trained in research work, preferably an industrial chemist of large general experience in analysis and testing of materials used in manufacturing, to undertake work of research engineer, specializing and becoming an authority on line of materials including copper, lead and tin alloys, felt, lubricants, explosives, paper, water-proofing, etc., with view to the improvement and extension of product. Man under 40 years of age preferred. Applicants are requested to give their experience in full; state age, positions occupied, and furnish list of references. To the right man permanent position is assured, at liberal salary. Location, Connecticut. (Reply by letter, addressed 086 Am.Soc.M.E.)

087 Works manager wanted. Old established and well organized company, employing about 1000 men, and manufacturing a high class product, wishes to secure a capable works manager of large experience in the production of small and accurate mechanisms, such as adding machines, typewriters, firearms, etc. Man under 40 years of age preferred. Applicants are requested to give their experience in full; state age, positions occupied, and furnish list of references. To the right man a permanent position is assured at liberal salary. Location New York State. (Reply by letter, addressed 087 Am.Soc.M.E.)

088 To take responsible position on staff of management in old established manufacturing concern employing from 80 to 100 men. Present owner technical graduate desires associate to join, taking equal interest, capable of holding leading position in matters pertaining to introduction of modern methods of scientific management and cost finding. Must be able to invest $35,000.

089 Turbine pump designer; must be competent engineer with extensive experience on highest grade turbine pump construction and designing. Location, Middle West.

090 Large concern located near New York City would like to secure services of technically trained draftsman who has had experience in designing paper cutting machines.

091 Factory manager of large manufacturing concern needs an assistant. Must be a technical graduate with several years' experience, progressive, and familiar with scientific shop methods. Twenty-five miles from New York.

092 Designer of automatic machinery, tools, jigs, fixtures; man with shop experience. Location, New Jersey.

093 Engineer for one year's contract, west coast of Africa, 3 deg. north of the equator, erecting and operating gas engine units of 1000 h.p.; must be capable of handling suction and pressure gas producers, knowledge of steam and electric pumps and air compressors.

094 Foundry foreman for yellow brass work, one working at present with concern manufacturing plumbers brass goods preferred. Executive ability required. Rapidly growing and strictly up-to-date plant; location, Delaware.

095 Technical graduate with at least four years' experience as assistant superintendent of electrical cable plant. Must have executive ability, be able to handle men and be thoroughly conversant with common electrical transmission problems.

096 Engineer wanted by chemical company, technical graduate with several years' practical experience in the design and supervision of mechanical installations in power plant and factories.

MEN AVAILABLE

199 Mechanical and structural engineer, wide experience in charge of design of furnace and rolling mills, general steel plant construction. Desires position as chief draftsman or assistant engineer.

200 Associate, at present assistant professor of mechanical engineering in one of the leading engineering colleges in the East, wishes employment for the period from May 10 to September 10. Experienced in testing and erecting power plant machinery and designing steam and gas engines. Would accept moderate salary for a position in designing or testing any kind of power plant machinery.

201 Electrical and mechanical engineer, 17 years' manufacturing, commercial and engineering experience, desires an executive position with manufacturing concern. Experienced in design of manufacturing plants and product; electric railway project work, modern methods of systematizing, cost and other accounting and factory management.

202 Engineer and salesman, gas engineer with electrical department of railroad lines in San Francisco; investigation of fuel resources and preparation of reports on costs of construction and operation of different types of large power and gas plants; desires position as engineer or salesman with by-product coke oven business. $3000 per year to start.

203 Mechanical engineer, technical graduate, eight years' general engineering and executive experience, operation, maintenance, design and manufacture. Desires position as superintendent, chief engineer, works manager, or assistant.

204 Mechanical engineer desires opening as sales engineer or a business connection with manufacturing firm. Age 27, college graduate, two years' experience as sales engineer. At present, erecting shop foreman with large locomotive works.

205 Member, with 15 years' experience in civil and mechanical engineering, especially hydraulics and steam engineering, desires teaching or commercial position.

206 Student member, thorough business and academic training, expects to graduate in mechanical engineering in June. Desires position with consulting engineer or engineering company. Experienced in erecting and testing engines for leading engine building company, manager of automobile garage, experimental engineering corps large steel works, also as assistant instructor in experimental engineering in college. Best of references furnished. Understands machine designing and has made special study of architecture.

207 Construction engineer, up to date on steam, electric power plants, water works, sewer systems for large industrial works, steam, water and electric cable distribution, substations, illumination, high voltage electric motor drives, gas producer plants, letting contracts and superintending work; age 33, technical graduate, married. Salary to begin, $2400.

208 Young engineer, Junior member, ten years' practical experience gas and gasoline engines. Desires position with engineering firm as superintendent of installation or charge of marine or stationary plants, or as sales manager.

209 Member, graduate Cornell, M.M.E. 1900, experienced in power generation, electric transmission and railway electrification, New York, Pacific Coast and Canada. At present, professor of electrical engineering. Wide experience in organization and business management.

210 Mechanical and civil engineer, age 30. Eight years' experience in design, construction and operation of waterworks, power plants and general construction work. Open for engagement May 18. At present in Southwest. Permanent position desired.

211 Graduate engineer with nine years' experience responsible positions in construction, operating and other departments of various industries, desires association of similar nature in vicinity of Philadelphia or New York.

212 Graduate mechanical engineer, Mass. Inst. Tech., three years' teaching engineering subjects; two years in practical work in New York. At present engaged in research work for degree of M.M.E. Desires position as professor in steam engineering.

213 Junior member, technical education, 15 years' experience, steam and oil engines, tools, hydraulic and general machinery. Four years' chief draftsman, one, shop foreman. At present employed designing special machinery. Age 33; desires position within commuting distance from Orange, N. J.

214 Associate; 15 years' experience on blast furnaces, steel, rolling, pipe and tube mills, coke ovens and chemical apparatus, as draftsman, squad foreman and checker, desires to locate in the East, preferably near Philadelphia.

215 Member desires to connect with manufacturing, contracting or engineering firm in position requiring progressive business ability as well as technical capacity. Wide experience in mechanical lines and some electrical, from drafting to supervision; sales engineer during past three years. Technical graduate 34 years of age.

216 Member; at present occupying an executive position with large machinery manufacturer, desires an engagement with either the manufacturing or selling departments of a live concern; engines, turbines, electrical machinery, power transmission or similar lines.

217 Graduate mechanical engineer, nine years' general experience with air compressor builders, design, testing, development of electric driven units, special problems in air and natural gas compression, sales engineering and publicity work; wants responsible position with compressor builders. At present employed.

218 Member desires position as engineer, chief draftsman or designer; 20 years' experience in various lines, as chief draftsman or mechanical engineer; experience in printing and other paper handling machinery.

CHANGES IN MEMBERSHIP

CHANGES OF ADDRESS

ALEXANDER, Ludwell Brooke (Junior,1905), Asst. Genl. Sales Mgr., Bosch Magneto Co., 223 W. 46th St., and Cliffwood Court, 179th St. and Ft. Washington Ave., New York, N. Y.

ANGSTROM, C. Jonas (1908), 3706 Bates St., Pittsburg, Pa.

ANGUS, Robert (1891), Cons. Engr., 705 Confederation Life Bldg., Toronto, Ont., Canada.

BACON, Charles James (1905; 1907), Steam Engr., Ill. Steel Co., South Chicago, and 7334 Palmer Ave., Chicago, Ill.

BALTZELL, Willie Harry (1910), Ch. Engr., Pittsburg Crucible Steel Co., Oliver Bldg., Pittsburg, Pa.

BANTA, Earle Jackson (1907), 105 Avenida Juarez, Mexico, D. F., Mex.

BEMENT, A. (1901), Cons. Engr., 206 S. La Salle St., and 2927 Warren Ave., Chicago, Ill.

BENNETT, Geo. G. (Junior, 1903), Efficiency Engr., Ludlow Mfg. Associates, and *for mail*, P. O. Box 75, Ludlow, Mass.

BIXBY, William P. (Junior, 1908), Union Wadding Co., Pawtucket, R. I.

BLAND, John P. (1901), Printer and Ch. Engr., The Times, and *for mail*, 48 Thurleigh Rd., Nightingale Lane, London, S. W., England.

BLUM, Joseph K. (Junior, 1909), Mech. Engr., Coplay Cement Mfg. Co., and *for mail*, 146 Central Park W., New York, N. Y.

BORDEN, Wm. H. (Junior, 1905), Box 189, Valdez, Alaska.

BOWERMAN, Myron Ralph (Junior, 1910), 2126 S. Central Park Ave., Chicago, Ill.

BROWN, Walter Ellsworth (Junior, 1910), Supt., Middleby Auto Co., and *for mail*, 806 N. 9th St., Reading, Pa.

BUSH, Harold Montfort (1894; 1905), Cons. Engr., 508 Capitol Trust Bldg., Columbus, and Briggsdale, O.

CARPENTER, Allan O. (Associate, 1909), Designing Dept., Ingersoll Rand Co., Painted Post, and *for mail*, 1 E. Pulteney St., Corning, N. Y.

COOK, John P. (Junior, 1906), 260 B Manning Blvd., Albany, N. Y.

COOK, William Henry (Junior, 1910), Am.Loco. Co., Cooke Wks., and *for mail* 56 18th Ave., Paterson, N. J.

CORK, Robert L. (Junior, 1907), Ch. Engr., Almont Mfg. Co., Almont, Mich.

COX, Frederick W. (1908), P. O. Box 496, Carson City, Nev.

CRAIG, James (1897), Mech. Engr., 807-841 Garfield Ave., Jersey City, N. J.

CRAIGHEAD, Magruder (Junior, 1910), Link-Belt Co., 131 State St., Boston, Mass.

CROGHAN, John T. (Associate, 1909), Stone & Webster Engrg. Corp., Plymouth Bldg., Minneapolis, Minn.

CUNNINGHAM, George H. (Junior, 1910), Consolidation Coal Co., Jewel, Ky

FERGUSON, Hardy Smith (1899), Cons. Engr., 200 Fifth Ave., New York, N. Y., and 82 Pine St., Portland, Me.

GAST, George Fred (Junior, 1910), Constr. Dept., Minnesota & Ontario Power Co., International Falls, and *for mail*, 2027 Oakland Ave., Minneapolis, Minn.

GERNANDT, Waldo George (Junior, 1910), Designer, Carriage Chassis Dept., Packard Motor Car Co., Detroit, Mich.

GREEN, Wm. O. (1891), Member of Firm, Ogden, Sheldon & Co., 192 N. Clark St., and 1211 Astor St., Chicago, Ill.

HILL, Reuben (1908), Supt., Detroit Lubricator Co., Detroit, Mich.

HOWELLS, Charles (1904), Box 164, Washingtonville, N. Y.

LANE, Francis W. (Associate, 1900), Engrg. Corr., London Times, Editor, Natl. Land and Irrigation Journal 30 S. Market St., amd *for mail*, 6438 Normal Ave., Chicago, Ill.

LATTA, Nisbet (Junior, 1902), V. P., Wisconsin Engine Co., Corliss, Wis.

LEE, Francis V. T. (1907), Cons. Engr., care of The Royal Colonial Inst., Northumberland Ave., London, W. C., England, and University Club., San Francisco, Cal.

LENT, Leon B. (1905), Ch. Engr., N. Y. Blaugas Co., Brewster, N. Y.

McDEVITT, Frank J. (Junior, 1906), Dist. Mgr., Elliott Co., and Liberty Mfg. Co. of Pittsburg, Pa., 351 Pierce Bldg., St. Louis, Mo.

McJILTON, John Perkins (Junior, 1910), Draftsmen, Loco. Superheater Co., 30 Church St., and *for mail*, 153 E. 86th St., New York, N. Y.

MAYSILLES, John Henry (1901; 1910), Supt., Davenport Loco. Wks., Davenport, Ia.

MORRISON, Clarke J. (1909), Effective Organization Dept., Suffern & Son, 165 Broadway, New York, N. Y., and *for mail*, 191 N. Walnut St., East Orange, N. J.

MOWERY, John N. (1906), M. M., N. Y. N. H. & H. R. R., Waterbury, Conn.

NICHOLS, Charles H. (1908), Cons. Engr., 1133 Broadway, and 63 W. 127th St., New York, N. Y.

PAUL, Charles Edward (1908), Assoc. Prof. Mechanics, Armour Inst. of Tech., and *for mail*, 6238 Ellis Ave., Chicago, Ill.

PENNOCK, George Alger (Junior, 1903), Asst. Supt., Service and Maintenance, Western Elec. Co., Hawthorne, Ill.

POTTS, S. Warren (1909), Mech. Engr., R. Hoe & Co., 504 Grand St., and *for mail*, 622 W. 135th St., New York, N. Y.

RANDALL, Dwight T. (1904), 70 Smith Ave., Detroit, Mich.

RIGGS, John D. (Junior, 1892), Ch. Draftsman, Oliver Chilled Plow Wks., and *for mail*, Genl. Delivery, South Bend, Ind.

SCOTT, J. Alvah (1900), Naval Arch. and Marine Engr., Ossining-on-Hudson, N. Y.

SHALLCROSS, Watson Comly (1910), Solvay Process Co., Detroit, Mich.

SHEPERDSON, John Wm. (Associate, 1908), Asst. Supt., Gautier Dept., Cambria Steel Co, and *for mail*, 126 Tioga St., Westmont, Johnstown, Pa.

SMITH, George Marshall (Associate, 1904), V. P. and Treas., A. E. Anderson & Co., 642 Prudential Bldg., Buffalo, N. Y., and 4632 N. Winchester Ave., Chicago, Ill.

STUTZ, C. C. (1900), Cons. Engr., 3830 Forest Ave., Norwood, O.

THRELFALL, William V. (1902), Textile Mchy., Mill and Power Equip., Marshall Bldg., 40 Central St., Boston, Mass.

WATSON, Henry D. (1897; 1900), East. Sales Mgr., Saurer Motor Co., 30 Church St., New York, and 136 E. 19th St., Flatbush, Brooklyn, N. Y.

WHITE, Herbert J. (1909), Wks. Mgr. and Mech. Engr., Krantz Mfg. Co., and *for mail*, 439 Eighth St., Brooklyn, N. Y.

WILLIAMSON, Leroy A. (Associate, 1902), Pres., L. A. Williamson Co., 258 Broadway, New York, N. Y.

WILSON, Robert Alexander (Junior, 1910), Constr. Engr., Snow Steam Pump Wks., Buffalo, N. Y.

WILSON, William L. (Junior, 1907), V. P., The Elec. Installation Co., 411 N. Charles St., Baltimore, Md.

WINTZER, Rudolph (1908), 685 Farwell Ave., Milwaukee, Wis.

WOLDENBERG Izydor (Junior, 1903), Dir. Ingersoll-Rand Co., m.b.H., Oststrasse 128–132, Düsseldorf, Germany.

WOOD, Thomas C. (Junior, 1909), 359 St. John's Pl., Brooklyn, N. Y.

WRIGHT, Wm. Quinby (1908), Min. and Civ. Engr., 727 Merchants Exch. Bldg., San Francisco, and Sausalito, Cal.

ZIMMERMAN, Oliver B. (1905), Engr., E. Burner & Co., South Bend, Ind.

NEW MEMBERS

CUMMINS, Peter Augustine (Junior, 1910), Special Apprentice, Shop Practice, Detroit Steel Products Co., and *for mail*, 30 Hazelwood Ave., Detroit, Mich.

DAVOCK, Harlow N. (Junior, 1910), 79 Garfield Ave., Detroit, Mich.

FIELD, Freeman (Associate, 1910), V. P. and Treas., Sheffield Gas Power Co., Kansas City, Mo.

NELSON, Bernard Stanley (Junior, 1910), Head Draftsman, A. M. Lockett & Co., and *for mail*, 533 Baronne St., New Orleans, La.

DEATHS

BROOKS, Paul Raymond, March, 11, 1911.
CALDWELL, George B., March 31, 1911.
HAMMARBERG, Arndt L., February 7, 1911.
HART, Frederick L., March 23, 1911.
HUNT, Charles Wallace, March 27, 1911.
WHITE, Everett H., January 12, 1911.
WILSON, Dwight Boyden, March 7, 1911.

GAS POWER SECTION

CHANGES OF ADDRESS

BARKER, John H. (Affiliate, 1908), Mgr., N. Y. Office, Diehl Mfg. Co., 90 Prince St., New York, and *for mail*, 466 E. 7th St., Brooklyn, N. Y.
BRENNAN, Daniel Aloysius (Affiliate, 1910), Designer and Erector, Wisconsin Eng. Co., Corliss, and *for mail*, 375 Superior St., Milwaukee, Wis.
CRAIG, James (1910), Mem.Am.Soc.M.E.
HOWELLS, Charles (1909), Mem.Am.Soc.M.E.
LATHROP, Jay Cowden (Affiliate, 1908), Iowa Traction Co., Oskaloosa, Ia.
LENT, Leon B. (1908), Mem.Am.Soc.M.E.
RANDALL, Dwight T. (1910), Mem.Am.Soc.M.E.
SHORKEY, Edward Louis (Affiliate, 1909), Gas Eng. Dept., Bethlehem Steel Co., and *for mail*, Leonard Hall, South Bethlehem, Pa.
WILSON, Robert Alexander (1909), Mem.Am.Soc.M.E.
ZIMMERMAN, Oliver B. (1908), Mem.Am.Soc.M.E.

NEW MEMBER

ONUKI, Riojo (Affiliate, 1910), Yokosuka Naval Dock Yard, Yokosuka, Japan.

STUDENT BRANCHES

CHANGES OF ADDRESS

BONNELL, W. W. (Student, 1910), 715 South Ave., Wilkinsburg, Pa.
CADY, Cecil I. (Student, 1909), care of The Sanitary Water Still Co., Jamaica, N. Y.
CAMPBELL, C. P. (Student, 1911), 245 Ramona St., Palo Alto, Cal.
COOK, G. C. (Student, 1909), 200 W. 81st St., New York, N. Y.
CRANE, Fred. L. (Student, 1909), The Westinghouse Club, Wilkinsburg, Pa.
CUMMINS, G. F. (Student, 1910), 3412 S. Park Ave., Chicago, Ill.
FAIRCHILD, F. P. (Student, 1910), 575 68th Ave., Milwaukee, Wis.
JEHLE, Ferdinand (Student, 1909), Genl. Motors Co., Detroit, Mich.
JOHNSON, C. E. (Student, 1909), 534 Madison St., Topeka, Kan.
PAGE, Wilsen K. (Student, 1909), 202 S. Union St., Olean, N. Y.
RICHARDSON, Lawrence (Student, 1909), 1704 Seventh Ave., Altoona, Pa.
RUGG, D. M. (Student, 1909), 540 Madison St., Gary, Ind.
SELDEN, G. D., Jr. (Student, 1911), 124 Sheff. Vanderbilt, New Haven, Conn.
SWIGGETT, C. A. (Student, 1909), 304 W. Madison St., Iola, Kan.
THOMPSON, Wm. H. (Student, 1909), 53 N. 13th St., Newark, N. J.
WILES, F. S. (Student, 1910), Syracuse, Neb.

NEW MEMBERS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

BREWSTER, E. W. (Student, 1911), Tech. Chambers, Irvington St., Boston, Mass.
CUSTER, L. L. (Student, 1911), 76 Huntington Ave., Boston, Mass.
HALL, Edward R. (Student, 1911), 1 Davis St., Wollaston, Mass.
NOYES, J. A. (Student, 1911), 124 Adams St., Waltham, Mass.

STEVENS INSTITUTE OF TECHNOLOGY

SKINNER, B. C. (Student, 1911), 1233 Bloomfield St., Hoboken, N. J.

UNIVERSITY OF MISSOURI

HECKER, A. J. (Student, 1911), 10 Lathrop Hall, Columbia, Mo.
HEPTONSTALL, A. E. (Student, 1911), 108 College Ave., Columbia, Mo.

COMING MEETINGS

May—June

Advance notices of annual and semi-annual meetings of engineering societies are regularly published under this heading and secretaries or members of societies whose meetings are of interest to engineers are invited to send such notices for publication. They should be in the editor's hands by the 15th of the month preceding the meeting. When the titles of papers read at monthly meetings are furnished they will also be published.

AIR BRAKE ASSOCIATION

May 23–26. annual convention, Auditorium Hotel, Chicago, Ill. Papers: Air Brake Instruction, Rating, T. Clegg, Geo. A Wyman, H. H. Burns, H. A. Wahlert, T. F. Lyons; Brake Cylinders and Connections, H. A. Wahlert; Adequate Braking Power for Freight Cars, J. P. Kelly; Cost of Maintenance of Locomotive Brakes, W. P. Huntley; Running Triple Valves without Lubricants, L. Leonard; Fibre Stresses in Brake Gear Parts, G. O. Hammond; "P. C." Equipment, W. V. Turner; Steel Pipe vs. Iron Pipe, J. R. Alexander; Recommended Practice, S. G. Down, G. R. Parker, H. A. Wahlert, N. A. Campbell, J. R. Alexander; Friction of New and Worn Brake Shoes on New and Worn Cast Wheels, A. S. Williamson; Breaking-in-two of Trains, S. H. Draper, P. J. Langan. Secy., F. M. Nellis, 53 State St., Boston, Mass.

AMERICAN ASSOCIATION OF REFRIGERATION

May 9–10, annual meeting, La Salle Hotel, Chicago, Ill. Secy., J. F. Nickerson, 431 S. Dearborn St.

AMERICAN FOUNDRYMEN'S ASSOCIATION
AMERICAN BRASS FOUNDERS' ASSOCIATION
ASSOCIATED FOUNDRY FOREMEN

May 23–26, annual convention, Pittsburg, Pa. Papers: Production Cost, Economic Foundry Insurance, Uniform Contracts, Unloading Methods, Use of Borings in Cupolas, Effect of Alloys in Cast Iron, Permanent Molds, Vanadium in Non-Ferrous Alloys, Determination of Nickel Bronzes, Pouring High Grade Bronzes, Rotary Blowers, Foundry Construction, Heating and Lighting Systems, Pattern Making, Molding Machines, Acid and Basic Open-Hearth Processes, Electric and Converter Furnaces for Steel Castings, Effect of Vanadium and Titanium on Steel, Corrosion of Brass Foundry Products, Pyrometer and the Aluminum Foundry, Non-Ferrous Foundry Economies, Equilibrium Diagrams, Molding Sand, Use of Alloys, Shot in Castings. Secy., Richard Moldenke, Watchung, N. J.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

June 21–24, annual meeting, Chicago, Ill. Reports by committees on Chemical Engineering Education and Standardization of Boiler Tests. Secy., J. C. Olsen, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

May 16, monthly meeting, 29 W. 39th St., New York. Annual convention, last of June, Chicago, Ill. Secy., R. W. Pope, 29 W. 39th St., New York.

AMERICAN INSTITUTE OF MINING ENGINEERS

June 6, Glen Summit meeting, Glen Summit Springs Hotel, Glen Summit Springs, Pa. Secy., Dr. Joseph Struthers, 29 W. 39th St., New York.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION

June 14–16, Spring Convention, Marlborough-Blenheim, Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

AMERICAN RAILWAY INDUSTRIAL ASSOCIATION

May 9–10, annual meeting, Detroit, Mich. Secy., Guy L. Stewart, 1328 Pierce Bldg., St. Louis, Mo.

AMERICAN SOCIETY FOR TESTING MATERIALS

June 27–30, annual meeting, Atlantic City, N. J. Secy., Edgar Marburg, Univ. of Penn., Philadelphia, Pa.

AMERICAN SOCIETY OF CIVIL ENGINEERS

June 13–16, annual meeting, Chattanooga, Tenn. Secy., C. W. Hunt, 220 W. 57th St., New York.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Monthly meetings: May 9, 29 W. 39th St., New York; May, 17, Boston, Mass. Spring Meeting, May 30–June 2, Pittsburg, Pa. Secy., Calvin W. Rice, 29 W. 39th St., New York.

AMERICAN WATER WORKS ASSOCIATION

June 6–10, annual convention, Rochester, N. Y. Secy., J. M. Diven, 14 George St., Charlestown, S. C.

CANADIAN GAS ASSOCIATION

June 22–24, annual meeting, Quebec City, Quebec. Secy., John Keillor, Hamilton, Ont.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

May 23–26, annual convention, Omaha, Neb. Secy., Harry D. Vought, 95 Liberty St., New York.

INTERNATIONAL RAILWAY FUEL ASSOCIATION

May 15–18, annual convention, Hotel Patten, Chattanooga, Tenn. Papers: Fuel Investigations under the Bureau of Mines, J. A. Holmes, Mem.Am. Soc.M.E.; How to Organize a Railway Fuel Department and Its Relation to other Departments, T. D. Smith; The Testing of Locomotive Fuel, F. O. Bunnell; Standard Locomotive Fuel Performance Sheet, F. C. Pickard; The Railway Fuel Problem in Relation to Railway Operation, R. Emerson; Petroleum, Its Origin, Production and Use as Locomotive Fuel, E. McAuliffe. Secy., D. B. Sebastian, 721 La Salle Station, Chicago, Ill.

IRON AND STEEL INSTITUTE

May 11–12, annual meeting, Institution of Civil Engineers, Great George Street, Westminster, London, S. W., England. Papers: On Temperature Influences on Carbon and Iron, E. Adamson; On the Chemical and Mechanical Relations of Iron, Chromium and Carbon, J. O. Arnold, A. A. Read; On the Growth of Cast Irons after Repeated Heatings, H. C. H. Carpenter; On the Relation of Impurities to the Corrosion of Iron, J. W. Cobb; On Magnetic Properties of some Nickel Steels with some notes on the Struct-

ures of Meteoric Iron, E. C. Glauert, S. Hilpert; Notes on a Process for the Dessication of Air by Calcium Chloride, F. A. Baubinè, E. V. Roy; On the Volumetric Estimation of Sulphur in Iron and Steel, T. G. Elliot; On the Action of Aqueous Solutions of single and mixed Electrolytes on Iron, J. N. Friend, J. H. Brown; On Iron-Silicon-Carbon Alloys, W. Gontermann; On the Influence of Vanadium upon Cast Iron, W. H. Hatfield: On the Organic Origin of the Sedimentary Ores of Iron, W. H. Herdsman; On Some Studies on Welds, E. F. Law, W. H. Merrett, W. P. Digby; On the Corrosion of Steel, P. Longmuir, On the Influence of 2 Per Cent of Vanadium on Steels of Varying Carbon Content, A McWilliam, E. J. Barnes; On Some Properties of Heat-Treated 3 Per Cent Nickel Steels, A. McWilliam, E. J. Barnes; On Mechanicalising Analysis as an Aid to Accuracy and Speed for Commercial Purposes, C. H. Ridsdale, N. D. Ridsdale; On Welding up of Blowholes and Cavities in Steel Ingots, J. E. Stead. Secy., G. C. Lloyd, 28, Victoria Street, London, S. W., England.

MASTER CAR BUILDERS' ASSOCIATION

June 19–21, Spring Convention, Marlborough-Blenheim, Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

NATIONAL ELECTRIC LIGHT ASSOCIATION

May 29–June 2, annual convention, New York. Secy., T. C. Martin, 29 W. 39th St.

NATIONAL FIRE PROTECTION ASSOCIATION

May 23–25, annual meeting, New York. Secy., F. H. Wentworth, 87 Milk St., Boston, Mass.

NATIONAL GAS AND GASOLINE ENGINE TRADES ASSOCIATION

June 20–23, Spring Convention, Detroit, Mich. Secy., Albert Stritmatter, Cincinnati, O.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

May 18–19, semi-annual meeting, Youngstown, O. Secy., Frank E Sanborn, Ohio State University, Columbus, O.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

June 27–29, annual convention, Pittsburg, Pa. Secy., H. H. Norris, Cornell University, Ithaca, N. Y.

SOCIETY OF AUTOMOBILE ENGINEERS

June 15–17, midsummer meeting, Dayton, O. Genl. Mgr., Coker F. Clarkson, 1451 Broadway, New York.

MEETINGS IN THE ENGINEERING SOCIETIES BUILDING

Date	Society	Secretary	Time
May			
4	Blue Room Engineering Society	W. D. Sprague	8.00 p.m.
9	American Society of Mechanical Engineers	C. W. Rice	8.15 p.m.
11	Illuminating Engineering Society	P. S. Millar	8.00 p.m.
11	Institute of Operating Engineers	M. W. Rice	8.00 p.m.
16	New York Telephone Society	T. H. Lawrence	8.15 p.m.
16	American Institute of Electrical Engineers	R. W. Pope	8.15 p.m.
17	American Railway Association	W. F. Allen	10.00 a.m.
19	New York Railroad Club	H. D. Vought	8.15 p.m.
22	National Isolated Power Plant Association	E. D. Fieux	8.00 p.m.
24	Municipal Engineers of New York	C. D. Pollock	8.15 p.m.
30–June 2	National Electric Light Association	T. C. Martin	all day
June			
1	Blue Room Engineering Society	W. D. Sprague	8 p.m.
8	Illuminating Engineering Society	P. S. Millar	8 p.m.
8	Institute of Operating Engineers	M. W. Rice	8 p.m.
20	New York Telephone Society	T. H. Lawrence	8.15 p.m.
26	National Isolated Power Plant Association	E. D. Fieux	8 p.m.

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PRESIDENT

E. D. Meier..New York

VICE-PRESIDENTS

Charles Whiting Baker..New York
W. F. M. Goss..Urbana, Ill.
Alex. C. Humphreys..New York

Terms expire at Annual Meeting of 1911

George M. Brill..Chicago, Ill.
E. M. Herr..Pittsburg, Pa.
H. H. Vaughan..Montreal, Can.

Terms expire at Annual Meeting of 1912

MANAGERS

H. L. Gantt..New York
I. E. Moultrop..Boston, Mass.
W. J. Sando..Milwaukee, Wis.

Terms expire at Annual Meeting of 1911

H. G. Stott..New York
James Hartness..Springfield, Vt.
H. G. Reist..Schenectady, N. Y.

Terms expire at Annual Meeting of 1912

D. F. Crawford..Pittsburg, Pa.
Stanley G. Flagg, Jr..Philadelphia, Pa.
E. B. Katte..New York, N. Y.

Terms expire at Annual Meeting of 1913

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Frederick W. Taylor..Philadelphia, Pa.
F. R. Hutton..New York
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Jesse M. Smith..New York
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Robert M. Dixon..New York

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Jesse M. Smith

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Geo. J. Roberts (1)
H. L. Doherty (4)
W. L. Saunders (5)

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Francis Blossom (2), *Chairman*
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Leonard Waldo (1), *Chairman*
Chas. L. Clarke (3)
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Alfred Noble (4)
E. G. Spilsbury (5)

MEETINGS

L. R. Pomeroy (1), *Chairman*
H. de B. Parsons (3)
Chas. E. Lucke (2)
Willis E. Hall (4)
C. J. H. Woodbury (5)

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Francis H. Stillman (1), *Chairman*
Hosea Webster (3)
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Theo. Stebbins (4)
W. H. Boehm (5)

PUBLICATION

H. F. J. Porter (1), *Chairman*
Geo. I. Rockwood (3)
Fred R. Low (2)
Geo. M. Basford (4)
Chas. I. Earll (5)

PUBLIC RELATIONS

James M. Dodge, (5), *Chairman*
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RESEARCH

W. F. M. Goss (3), *Chairman*
Ralph D. Mershon (2)
R. H. Rice (1)
Jas. Christie (4)
R. C. Carpenter (5)

Note.—Numbers in parentheses indicate number of years the member has yet to serve.

SPECIAL COMMITTEES
1911

On a Standard Tonnage Basis for Refrigeration

D. S. Jacobus — G. T. Voorhees
A. P. Trautwein — Philip De C. Ball
E. F. Miller

On Society History

John E. Sweet — H. H. Suplee

On Constitution and By-Laws

Jesse M. Smith — F. R. Hutton
G. M. Basford — D. S. Jacobus

On Conservation of Natural Resources

Geo. F. Swain, *Chairman* — L. D. Burlingame
Charles Whiting Baker — M. L. Holman
Calvin W. Rice

On Identification of Power House Piping

H. G. Stott, *Chairman* — H. P. Norton
I. E. Moultrop — J. T. Whittlesey
F. R. Hutton

On International Standards for Pipe Threads

E. M. Herr, *Chairman* — Geo. M. Bond
William J. Baldwin — Stanley G. Flagg, Jr.

On Standards for Involute Gears

Wilfred Lewis, *Chairman* — E. R. Fellows
Hugo Bilgrim — C. R. Gabriel
Gaetano Lanza

On Power Tests

D. S. Jacobus, *Chairman* — L. P. Breckenridge — Edward F. Miller
Edward T. Adams — William Kent — Arthur West
George H. Barrus — Charles E. Lucke — Albert C. Wood

On Standardization of Flanges

A. C. Ashton — J. P. Sparrow
Wm. Schwanhausser — H. G. Stott

On Student Branches

F. R. Hutton, Honorary Secretary

Tellers of Election Officers and Members

Wm. T. Donnelly — Geo. A. Orrok — Theo. Stebbins

Nominating Committee Officers 1912

R. C. Carpenter, *Chairman*, New York — A. M. Hunt, San Francisco, Cal.
R. H. Fernald, Cleveland, O. — E. G. Spilsbury, New York
C. J. H. Woodbury, Boston, Mass.

MEETINGS OF THE SOCIETY

THE COMMITTEE ON MEETINGS

L. R. Pomeroy, (1) *Chairman* — H. de B. Parsons (3)
Chas. E. Lucke (2) — Willis E. Hall (4)
C. H. J. Woodbury (5)

Meetings of the Society in Boston

Ira N. Hollis, *Chairman* — I. E. Moultrop, *Secretary*
Edward F. Miller — James D. Andrew
Richard H. Rice

Meetings of the Society in New York

Walter Rautenstrauch, *Chairman* — Fredk. A. Waldron, *Secretary*
F. H. Colvin — Edward Van Winkle
Roy V. Wright

Meetings of the Society in St. Louis

Ernest L. Ohle, *Chairman* — Fred E. Bausch, *Secretary*
M. L. Holman — R. H. Tait
John Hunter

Meetings of the Society in San Francisco

A. M. Hunt, *Chairman* — T. W. Ransom, *Secretary*
W. F. Durand — E. C. Jones
Thomas Morrin

Meetings of the Society in Philadelphia

Thomas C. McBride, *Chairman* — D. R. Yarnall, *Secretary*
A. C. Jackson — J. E. Gibson
W. C. Kerr — J. C. Parker
James Christie

SUB-COMMITTEES OF COMMITTEE ON MEETINGS

On Machine Tools

Willis E. Hall, *Chairman* — John Parker Ilsley
Walter Rautenstrauch

On Economic Administration of Industrial Establishments

Chas. B. Going, *Chairman* — James Hartness
C. U. Carpenter — Worcester R. Warner

Mechanical Engineering of Textile Industry

Charles T. Plunkett, *Chairman*, Adams, Mass.
Daniel M. Bates, Wilmington, Del. — Franklin W. Hobbs, Boston, Mass.
John Eceles, Taftville, Conn. — C. R. Makepeace, Providence, R. I.
Edw. W. France, Philadelphia, Pa. — C. H. Manning, Manchester, N. H.
Edward F. Greene, Boston, Mass. — Henry P. Mansfield, Utica, N. Y.
Edward W. Thomas, Lowell, Mass.
C. J. H. Woodbury, Boston, Mass.

SOCIETY REPRESENTATIVES

1911

On John Fritz Medal

F. R. Hutton (1) | Henry R. Towne (3)
John A. Brashear (4)

On Board of Trustees United Engineering Societies Building

Fred J. Miller (1) | Jesse M. Smith (2)
Alex. C. Humphreys

On National Fire Protection Association

John R. Freeman | Ira H. Woolson

On Joint Committee on Engineering Education

Alex. C. Humphreys | F. W. Taylor

On Advisory Board National Conservation Commission

Geo. F. Swain | John R. Freeman
Chas. T. Main

On Council of American Association for the Advancement of Science

Alex. C. Humphreys

International Association for Testing Materials
Committee on Nomenclature of Iron and Steel

Charles Kirchhoff.

Note.—Numbers in parentheses indicate number of years the member has yet to serve.

OFFICERS OF THE GAS POWER SECTION

1911

CHAIRMAN
R. H. Fernald

SECRETARY
Geo. A. Orrok

GAS POWER EXECUTIVE COMMITTEE

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G. I. Rockwood (1)
C. J. Davidson (1)
E. D. Dreyfus (1)
F. R. Hutton (2)
H. H. Suplee (3)
F. R. Low (4)

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A. E. Johnson
F. S. King
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George W. Whyte
S. S. Wyer

GAS POWER MEETINGS COMMITTEE

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W. H. Blauvelt
E. D. Dreyfus
A. H. Goldingham
Nisbet Latta
H. B. MacFaralnd

GAS POWER LITERATURE COMMITTEE

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H. G. Wolfe
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S. I. Oesterreicher
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GAS POWER PLANT OPERATIONS COMMITTEE

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C. J. Davidson
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H. J. K. Freyn
W. S. Twining
C. W. Whiting

Note.—Numbers in parentheses indicate number of years the member has yet to serve.

OFFICERS OF STUDENT BRANCHES

INSTITUTION	DATE AUTHORIZED BY COUNCIL	HONORARY CHAIRMAN	PRESIDENT	CORRESPONDING SECRETARY
	1908			
Stevens Inst. of Tech., Hoboken, N. J.	December 4	Alex. C. Humphreys	W. G. H. Brehmer	J. G. Bainbridge
Cornell University, Ithaca, N. Y.	December 4	R. C. Carpenter	A. W. de Revere	D. S. Wegg, Jr.
	1909			
Armour Inst. of Tech., Chicago, Ill.	March 9	G. F. Gebhardt	C. E. Beck	F. H. Griffiths
Leland Stanford Jr. University, Palo Alto, Cal.	March 9	W. R. Eckart	H. H. Blee	E. L. Ford
Polytechnic Institute, Brooklyn, N. Y.	March 9	W. D. Ennis	A. L. Palmer	R. C. Ennis
Purdue University, Lafayette, Ind.	March 9	L. V. Ludy	L. Jones	H. E. Sproull
University of Kansas, Lawrence, Kan.	March 9	P. F. Walker	W. H. Judy	M. C. Conley
New York Univ., New York City	November 9	C. E. Houghton	Harry Anderson	Andrew Hamilton
Univ. of Illinois, Urbana, Ill.	November 9	W. F. M. Goss	F. J. Schlink	E. J. Hasselquist
Penna. State College, State College, Pa.	November 9	J. P. Jackson	W. E. Heibel	G. M. Forker
Columbia University, New York City	November 9	Chas. E. Lucke	F. T. Lacy	J. L. Haynes
Mass. Inst. of Tech., Boston, Mass.	November 9	Gaetano Lanza	J. A. Noyes	R. M. Ferry
Univ. of Cincinnati, Cincinnati, O.	November 9	J. T. Faig	H. B. Cook	C. J. Malone
Univ. of Wisconsin, Madison, Wis.	November 9	H. J. B. Thorkelson	F. B. Sheriff	L. F. Garlock
Univ. of Missouri, Columbia, Mo.	December 7	H. Wade Hibbard	F. T. Kennedy	Osmer N. Edgar
Univ. of Nebraska, Lincoln, Neb.	December 7	C. R. Richards	W. J. Wholenberg	W. H. Burleigh
	1910			
Uiv. of Maine, Orono, Me.	February 8	Arthur C. Jewett	A. H. Blaisdell	W. B. Emerson
Univ. of Arkansas, Fayetteville, Ark.	April 12	B. N. Wilson	W. Q. Williams	H. W. Barton
Yale University, New Haven, Conn.	October 11	L. P. Breckenridge	ClaytonDuBosque	W. St. C. Childs
Rensselaer Poly. Inst., Troy, N. Y.	December 9	A. M. Greene, Jr.	G. K. Palsgrove	H. J. Parthesius
	1911			
State Univ. of Ky., Lexington, Ky.	January 10	F. P. Anderson	G. C. Mills	H. L. Moore
Ohio State University, Columbus, O.	January 10	W. T. Magruder	H. A. Shuler	H. M. Bone
Washington, Univ., St Louis, Mo.	March 10			F. E. Glasgow